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Theory of Glass Tank Block Corrosion

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Introduction

The corrosion of glass tank blocks has long been recognized as one of the most important problems of the glass industry. The peculiar action of molten glass on clay refractories offers an excellent opportunity for speculation as to just why the corrosion proceeds as it does. Various theories have been advanced to explain tank block corrosion.

Corrosion of the clay refractories is exceptionally rapid at the glass line. In general, it has been found that glass tank "flux blocks" exposed to molten glass are worn away much more rapidly on the downward facing surfaces. On the other hand, upward facing surfaces show relatively little wear. Below the glass level, corrosion seems to originate and proceed most rapidly at horizontal cracks or joints in the clay wall. This gives rise to the "step-like" appearance of a wall which is partially worn. Fig. 1 shows a cross section through a wall which has been in service and illustrates the general appearance of partially worn walls. Another type of corrosion is "honey-combing," the holes extending in an upward direction often giving rise to the familiar stalactites and, combined with surface corrosion, vertical ridges on blocks exposed to molten glass. Bottom blocks have been known to be irregularly worn.

Theories of Corrosion

Of the various theories advanced to explain corrosion of glass tank blocks, the following have received attention:

1. Floating salts rich in alkali.
2. Erosion due to movement of glass.
   (a) Vertical convection currents.
   (b) horizontal flow.
3. Density of clay laden glass.

1. The corrosion of blocks proceeds rather rapidly at the glass line. Aside from effect of atmosphere, a plausible explanation for this phenomenon lies in the generally accepted fact that molten alkali salts float on the main body of glass, it being assumed that the corrosion of the refractories is accelerated by the presence of alkalies. Floating alkali salts together with elevated temperatures may explain the wearing away of tank blocks at the glass level but, obviously, offer no explanation for the corrosion which takes place below the surface of the glass.

2. Efforts have been made to explain tank block corrosion by attributing it to convection currents, it being assumed that the specific gravity of the glass adjacent to the tank walls is greater than that in the middle of the tank due to lower temperatures near the walls. Therefore, the assumption is made that the glass near the tank walls tends to flow downward while that near the middle of the tank tends to flow upward. Assuming this to be correct, it is conceivable that the actual abrasion of the glass would wear away the surface of the refractories. Also, any clay-saturated glass would be removed as rapidly as formed, thus preventing the establishment of an equilibrium. This theory would account for vertical ridges on the tank walls but it is difficult to understand how it can explain the step-like appearance of partially worn walls, honey-combing or the relatively rapid corrosion of downward facing surfaces as compared to vertical and upward facing surfaces. Neither can it explain the irregular wearing of bottom blocks so often observed.

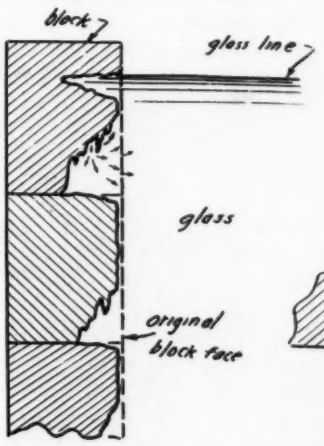

FIG. 1

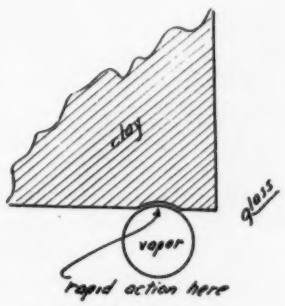

FIG. 2

It has been proposed that corrosion of tank blocks is due to the flow of the glass as it travels through the tank. If the

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wearing of the blocks were due to the flow of the glass, it would seem that the ridges on the face of the walls should extend in a horizontal direction. However, ridges on partially worn blocks almost invariably extend in a vertical direction, a fact wholly out of harmony with the above mentioned view. It is rather difficult to see how the flow of glass through the tank can explain the step-like appearance of the partially worn walls. Likewise, it cannot explain honeycombing or the irregular corrosion of bottom blocks.

3. A theory which has been generally accepted is based upon the assumption that the resulting glass formed by the solution of the clay refractories has a greater specific gravity than the ordinary soda-lime glass. If one assumes that a tank block is composed of, say, sixty per cent silica and thirty-six per cent alumina, the glass formed by its complete solution with sodium and calcium oxides would have a specific gravity of about 2.8, as calculated from the Winkelmann and Schott density factors. This value is calculated by assuming that sufficient lime and soda be used to form the compounds $Na_2Si_2O_5$, $NA1O_2$, $CaSiO_3$ and $Ca(A1O_2)_2$. It is not presumed that these compounds are necessarily formed or that the exact amount of lime and soda represented would be required for the completed solution of the alumina and silica or that the density factors are strictly correct. However, it does seem probable that the glass formed by corrosion of the blocks is heavier than the original soda-lime glass. It is argued that this aluminous glass, being heavier than the soda-lime glass, sinks toward the bottom of the tank and collects upon the upward facing surfaces protecting them from further corrosion because of its being practically saturated with clay material. As a matter of fact, the density of samples of glass taken from upward facing surfaces in the wall has been determined and is said to be practically the same as that of the rest of the glass in the tank. This clay laden glass probably does tend to sink but, due to diffusion and the fact that so little clay is dissolved, it soon loses its identity. If this aluminous glass does sink, it should build up a higher concentration on the lower parts of vertical surfaces and protect them more than the upper parts. Thus corrosion of vertical surfaces would be most rapid on the upper portions. If protection of clay surfaces is accomplished by the sinking of clay laden glass, a horizontal wall joint two feet below the glass level should have excellent protection by virtue of the clay-glass solution flowing downward from above—a supposition which does not fit experience very well. Fig. 1 shows a diagramatic sketch of the course probably followed by aluminous glass as it forms in a vertically extending hole and flows downward until it reaches the main body of glass, after which its downward course as an entity gradually gives way to diffusion in all directions. The "density" theory offers a fair explanation for the rapid corrosion of free downward facing surfaces and the slow corrosion of upward facing surfaces. However, it only offers a partially satisfactory explanation for the formation of honey-combed blocks and vertical ridges appearing on the face of blocks. In addition to this, it fails almost completely to explain the irregular corrosion of bottom blocks as well as the fact that the lower part of vertical surfaces often wears away more rapidly than the upper part, especially near submerged horizontal joints of tank blocks.

Importance of the Vapor Phase

Although much consideration has been given in the past to the part played by corrosive compounds and to the part played by the various physical conditions and chemical compositions of the fluid glass, little attention has been given to the vapor phase.[1] The action of glass on clay walls is not a simple process of solution, such as the dissolving of rock salt by water. Three phases are existent at the boundary between the tank blocks and the molten glass, namely, solid, liquid and vapor. In ordinary glass, there is present a complex system composed of $A1_2O_3$, SiO_2, Na_2O, CaO, MgO and small amounts of other oxides. Corrosion of the blocks is certainly due to the solvent action of the molten glass and to the formation of liquids of eutetic composition and their solvent action upon the remaining solid constituents. The gases found in or near molten glass consist not only of carbon dioxide, water, etc., but also of the alkalies and their volatile compounds or even arsenic if it is present in the glass. Although the molten glass as such may not be able to penetrate the refractories, it is obvious that the alkali vapors originating from the glass do have the ability to penetrate the pores of the blocks.[2] These volatile alkali compounds would tend to build up a relatively high concentration of alkali near the surface of the bock exposed to the glass. Under the temperature conditions prevailing, they react with the alumina and silica forming liquids which, in conjunction with the glass, exert solvent action on the remaining solid constituents. This heavy aluminous glass may flow away more slowly from upward facing surfaces than from either vertical or downward facing surfaces. Any unprotected downward facing surface will collect gas bubbles originating below it. Molten glass penetrates a small distance into the space formed by joints in the wall. Thus, the edge of a block at a joint is exposed to the attack of glass and alkali from two directions and, consequently, wears away more rapidly than a face which is exposed in only one direction. In the case of a horizontal joint, the downward facing surface is subject to action of bubbles containing alkali which, in conjunction with the relatively rapid diffusion from this surface, cause it to wear away more rapidly than the upward facing surface, forming the familiar step-like, honey-combed and vertical ridged surface of wall blocks.

Irregular corrosion of bottom blocks may be due to physical and chemical heterogeneity. Diffusion of the clay laden glasses probably takes place rather slowly from upward facing surfaces so that bottom blocks even at like temperatures wear away less rapidly than wall blocks. Since bottom blocks cannot entrap gas bubbles and since diffusion of clay laden glass from their surfaces may be comparatively slow, a relatively slow and uniform corrosion of bottom blocks is to be expected, but the thermal history of the block must not be neglected as a factor here.

Assume a bubble of, say, CO_2 entrapped by a clay block such as is represented by Fig. 2. Owing to surface tension and viscosity of the glass, the bubble is unable to break

[1] It should be noted that McCauley, Payne, Sosman, and others have discussed this possibility (unpublished remarks).
[2] Booze, *Fuels and Furnaces* 4, 425 (1926).

through the surface. At any given temperature there would be in this bubble a concentration of alkali because of the vapor pressure of the alkali glass, either due to volatile compounds or to dissociation of non-volatile compounds. Assume that sufficient alkali is removed from the layer of glass adjacent to the block by interaction with the alumina and silica to reduce the vapor pressure of the alkali in this glassy layer below that of the alkali in the remainder of the magma. Under these conditions, alkali leaves the bubble and enters the layer of glass laden with clay. The concentration of alkali in the bubble will remain constant at any given temperature; hence, more alkali enters the bubble from the main body of glass until equilibrium is again restored. Therefore, the block wears away quite rapidly in the neighborhood of a bubble. In other words, entrapped bubbles simply bore their way into the blocks, thus giving rise to a honeycombed structure. In addition to this, vertical ridges and honey-combing may be caused, of course, by lack of uniformity in the blocks.

Corrosion is quite rapid at the glass level due to presence of alkali and influence of furnace atmosphere and perhaps higher temperatures, surface tension effects, etc. The increased alkali content naturally accelerates solution of the silica and alumina in the block, doubtless forming a relatively fluid glass which soon diffuses away and leaves a fresh surface for attack.

Conclusions

It is thought that some theories of tank block corrosion are not completely satisfactory. The résumé here presented offers a rational explanation for the types of corrosion exhibited in practice. The presence and influence of a vapor phase should certainly be considered with other factors in discussion of this subject.

Compressed Air in the Glasshouse

Engineering Data for Its Efficient Production

By T. E. Kirch*

Compressed air for mechanical purposes had been known for probably four thousand years before it was applied to the glass industry. The past decade certainly has tried to make up for that lost time. There are hundreds of different types of machines and devices now in use in this industry depending on compressed air. The entire progress and rapid development of the mechanical manipulation of glass is due to the application and use of air operated and controlled machinery. There has been no other development that has had the far reaching effect and diversity of application in the art of glass manufacture. It has brought about the economical results which have been the making of this wonderful industry.

In spite of the universal use of nominally high pressure air there is a surprising lack of knowledge of its laws and limitations. We seldom enter a plant where there is not some problem to be worked out or some information desired about the compressed air system. There is nothing so discouraging as to try to operate a pneumatically equipped plant when there is air difficulty. In the following paragraphs we will try to cover the points brought out in our experience and to answer some of the commoner questions.

The first complaint that is heard in every glass plant is that there is a lack of sufficient air. The reasons for this are many, sometimes psychological and often real. They frequently require considerable study for their solution. Very often the capacity of the compressing plant is not great enough, in fact, too often. Equipment is purchased for a certain number of units. Sometime later another unit is added without any thought of the capacity of the compressor or perhaps it is speeded up a little. If it will stand that, it may even be tried again, until difficulty is encountered and then the glass machines are invariably blamed for the trouble.

A very common cause of poor air efficiency is the compressor valves. These valves must be kept in perfect condition and are just as important as those in your automobile. We know of one plant where the valves are removed and cleaned several times a week in one compressor. It is obvious that there is something very radically wrong there; it might be added that this plant does not pay dividends. The causes of such troubles should be traced immediately. We have operated compressors for six months without cleaning the valves and when examined they were in good condition.

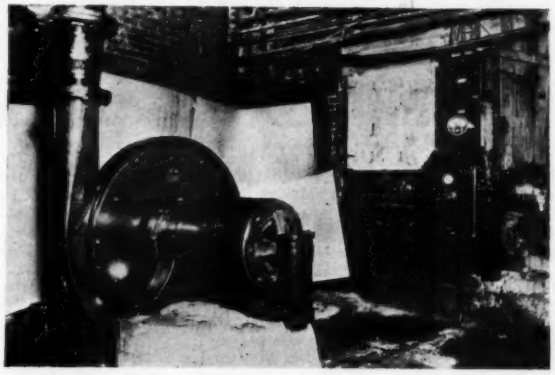


FIG. 1—G. E. MOTOR DRIVEN CENTRIFUGAL AIR COMPRESSOR 3-Lb. pressure. One of four machines of this type at Monogah Glass Company, Fairmont, W. Va., used for cooling glass and molds and men.

Proper lubrication is very important. The best special compressor oil made should be used. The proper amount must be fed so as to give ample lubrication and not cause an accumulation of oil in the lines and reservoirs. Consult your oil salesman about the grade of oil you should use. The better oil companies have lubrication experts to help you with such problems. The following table published

* Engineering Department, Nivison-Weiskopf Co., Reading, Ohio.

by the Compressed Air Society will serve as a guide and specifies the approximate quantity of oil for lubrication of air cylinders.

TABLE I. QUANTITY OF AIR-CYLINDER LUBRICANT REQUIRED

Size of cylinder, inches	Displacement per minute cu. ft.	Piston speed feet per minute	Sq. ft. of cyl. wall swept by piston	Drops of oil per minute	Drops of oil per 10 hours	Sq. ft. oiled per drop	Pints of oil per 10 hours
6 × 6	57	330	440	1	600	440	0.0375
8 × 8	124	354	740	2	1,200	370	0.0750
10 × 10	228	416	1,095	2	1,200	548	0.0750
12 × 12	371	470	1,480	3	1,800	493	0.1125
14 × 15	561	525	1,930	4	2,400	483	0.1500
16 × 15	730	525	2,200	4	2,400	550	0.1500
18 × 15	930	525	2,480	5	3,000	496	0.1875
20 × 15	1,146	525	2,770	6	3,600	462	0.2250

Steam driven compressors are used in quite a few plants. It requires a good grade of steam cylinder oil due to the constant washing away by the steam. The following table gives the approximate quantity of lubricant needed.

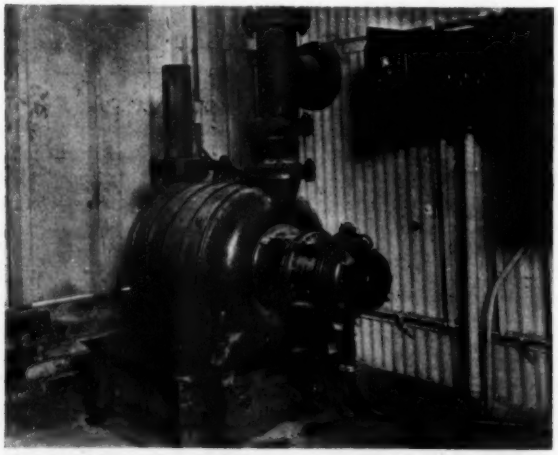


FIG. 2. G. E. CENTRIFUGAL AIR COMPRESSOR

Miniature Multistage Set, 2½ lb. pressure. Substantial economy in power expenditure is obtained by using this type of compressor for innumerable small purposes in the glass factory instead of wasting high pressure air in places where it is not required. The machine shown above was installed in a drawn sheet glass factory for blowing away chips of glass from machinery.

TABLE 2. OIL REQUIRED FOR STEAM-CYLINDER LUBRICATION

Size of cylinder, inches	Drops of oil per minute	Pints of oil per 10 hours
6 × 6	3	0.3
8 × 8	4	0.4
10 × 10	6	0.6
12 × 12	8	0.8
14 × 15	11	1.1
16 × 10	11	1.1
18 × 15	14	1.4
20 × 12	14	1.4
24 × 15	20	2.0

We are partial to taking the intake air from inside of the building in spite of the fact that most compressor manufacturers recommend outside. Every possible precaution must be taken to keep dirt, batch dust, etc., away from the inlet. Less trouble from moisture due to climatic changes occurs with an indoor intake.

Every compressor should be equipped with a relief valve of good make and it must be set to function properly. When the compressor pumps steadily there is something wrong some place and the air supply to the machines cannot be steady. The relief valve should be set to operate about three pounds and not over five pounds variation in pressure.

Leaks in lines, reservoirs, etc., must be avoided. The amount of air that will escape from a very small hole is tremendous. A round hole only 1/64 inch in diameter will cause a loss of 400 cubic feet of free air per day on a pressure of sixty pounds. Air leaks are just as important as steam leaks and far more costly.

Another very common cause of the shortage of air is the burners used to heat the feeders, in ring holes, etc., when compressed air is used with the fuel. Most operators do not realize that the quantity of air consumed is astonishing. A hole only one-eighth inch in diameter will consume ten cubic feet of free air per minute when compressed to only thirty pounds. That is sufficient air to operate a fairly large glass machine. Equip your burners to operate with fan air, or install low pressure centrifugal compressors, which are nothing more than fan blowers refined in construction details and efficiency. Where necessary, use high pressure burners to warm up Sunday nights only.

The reservoir in each separate factory should be equipped with a standard recording pressure gauge. This has a wonderful psychological effect, especially on those operators who are continually blaming their difficulties on the lack of air. It furnishes an indisputable record in cases where there is variation and helps to trace such difficulties.

At the machines themselves one of the meanest things to be up against is water in the air. Rusty valves and sticking cylinders are the plague of the air system not properly designed. False cushions and faulty valve action is frequently caused by water.

There is always water vapor in the atmosphere where life exists. At standard pressure at sea level and at the temperature of 62° F. fully saturated air contains 0.00088 pounds of water per cubic foot. It is safe to say that at any place where a glass factory can be found that the air will contain at least 50% of saturation and it is safe to use this figure for calculations. On this basis the amount of water that will be found in compressed air will be ½ of

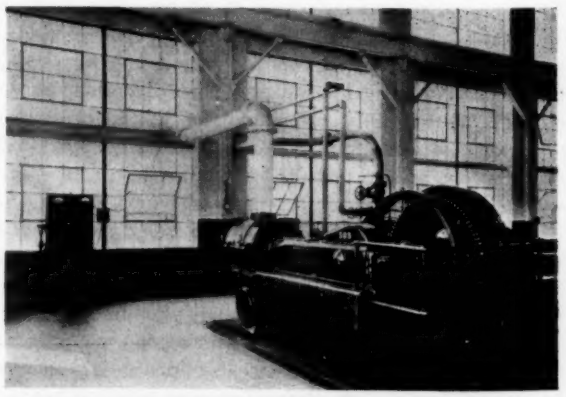


FIG. 3. AIR COMPRESSOR DRIVEN BY G. E. SYNCHRONOUS MOTOR

At United States Sheet & Window Glass Company, Shreveport, La.

0.00088 times the number of cubic feet of free air per minute being compressed. Where the exact hygrometric conditions are known, the corrected percentage can be used.

Example: How much water is to be expected per hour in a system compressing 100 cubic feet per minute at standard temperature?

$$\frac{\frac{88}{100{,}000} \times 60 \times 100}{2} = 2.64 \text{ pounds of water.}$$

It is a known fact that warm air will carry more moisture than cold air. At 92° F. it will carry three times as much water as at 62° or nine times as much as at 32°. This would suggest preheating the air.

We have found that the most difficulty from water in the air arises when the compressors are situated some distance

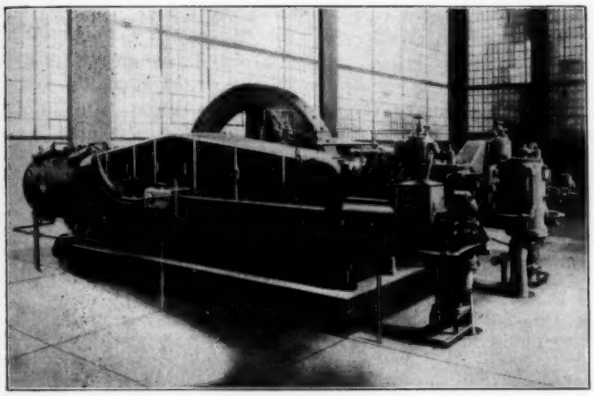


FIG. 4. AIR COMPRESSORS DRIVEN BY C. & G. COOPER SINGLE-ACTING TWIN GAS ENGINES, 170 B. H. P.

from the machines and in another building. The air cools during its long travel and moisture condenses in the line. The method we have found most successful to take care of this is to run the main line into a tank located near the machines and preferably set in a warm place. Both the incoming and the outlet air lines should drain toward this receiver which must be systematically drained. The main air line to the machines is then led off the top of this tank and across the crown of the tank furnace. It is sometimes advisable to make a coil of several turns of pipe over the furnace to heat the air properly. This must be worked out so that the air is heated to a point where it is just possible to hold the hand on the incoming air line at the machines. If it is colder the maximum efficiency is not obtained. If it is allowed to become too hot it will damage rubber hose, reducing valves, etc., and cause the lubricating oil to lose its viscosity and lubricating qualities.

The outlets to the machines from the end of the coil should consist of a tee the same size as the coil set facing up. A nipple about a foot or two long then forms a stand-pipe from the top of which the smaller line leads off to the machine. This stand-pipe acts as an additional water separator. We have found it best to go back to the end of the coil and sometimes even to the reservoir for each separate machine, especially for automatic glass feeders. Every precaution must be taken to avoid volume and pressure variations as well as water.

This reheating of compressed air should never be neglected even when there is no trouble with water. The proper heating alone is responsible for a power saving of 25 to 35%. This is one of the economies neglected in the majority of glass factories.

Another question that we have often been asked is just how large a line must be run to carry the air properly. The following table should be of considerable help.

TABLE 3. THE DIAMETER OF PIPE WHICH WILL DISCHARGE EQUIVALENT FREE AIR IN CUBIC FEET PER MINUTE FOR EACH 500 FEET LENGTH, WITH VARIOUS REDUCTIONS IN FINAL PRESSURE. INITIAL GAUGE PRESSURE 45 POUNDS.

Diam. of pipe	Reduction of Final Pressure in 500 Feet						
	1 lb.	2 lbs.	3 lbs.	5 lbs.	7 lbs.	9 lbs.	12 lbs.
	Cubic Feet of Free Air Per Minute						
1 in.	14	20	24	30	34	37	40
1¼ "	26	36	44	54	62	68	74
1½ "	43	60	72	90	102	112	121
2 "	95	132	159	198	226	247	268
2½ "	172	239	287	358	409	446	484
3 "	281	390	470	585	667	728	791
3½ "	419	583	701	874	997	1,080	1,180
4 "	595	827	995	1,240	1,410	1,540	1,670
4½ "	806	1,120	1,340	1,680	1,910	2,090	2,270
5 "	1,050	1,470	1,770	2,200	2,510	2,740	2,980
6 "	1,690	2,350	2,820	3,520	4,020	4,380	4,760
7 "	2,500	3,480	4,190	5,220	5,950	6,500	7,060
8 "	3,520	4,900	5,890	7,340	8,370	9,140	9,930
9 "	4,770	6,630	7,970	9,930	11,300	12,300	13,400
10 "	6,240	8,680	10,400	13,000	14,800	16,100	17,600

Example: What size pipe must be used to deliver 1,000 cubic feet of free air per minute at the end of 1,000 feet of pipe, an allowance of not more than 5 pound loss in pressure being permitted.

As the table is for 500 feet of pipe only one-half of the loss of five pounds will be allowed in 500 feet. The nearest to two and one-half pounds is two pounds. Under the heading of two pounds find the size of pipe that will deliver 1,000 cubic feet. It is seen that 4½ inch pipe must be used which will deliver 120 cubic feet extra. A four inch pipe will deliver 995 cubic feet with a six pound loss. It is advisable to use the larger size due to the losses in pressure through valves, elbows, etc.

As the above table covers only straight pipe the losses due to valves, elbows, tees, etc., must be considered. The losses are shown in Table 4 in equivalent lengths of straight pipe.

TABLE 4. LOSS IN PRESSURE DUE TO GLOBE VALVE EXPRESSED IN ADDITIONAL LENGTH OF PIPE

Diameter of pipe	1	1½	2	2½	3	3½	4	5	6	7	8	10	12 inches
Additional length	2	4	7	10	13	16	20	28	36	44	53	70	88 feet

TABLE 5. LOSS IN PRESSURE DUE TO ELBOWS AND TEES EXPRESSED IN ADDITIONAL LENGTH OF PIPE

Diameter of pipe	1	1½	2	2½	3	3½	4	5	6	7	8	10	12 inches
Additional length	2	3	5	7	9	11	13	19	24	30	35	47	59 feet

Another question often asked is what it costs to manufacture compressed air. First we must consider a table showing the power it takes, for use later in the calculations.

TABLE 6. INDICATED OR BRAKE HORSE POWER TO COMPRESS 100 CUBIC FEET OF DISPLACEMENT

Displacement per Minute by Single Stage Compression at Sea Level

Gauge pressure	Horse power	Gauge pressure	Horse power	Gauge pressure	Horse power	Gauge pressure	Horse power	Gauge pressure	Horse power
5	2.35	25	9.00	45	12.4	65	14.3	85	16.0
10	4.35	30	10.20	50	13.0	70	15.0	90	16.7
15	6.20	35	11.20	55	13.2	75	15.5	95	17.2
20	7.56	40	12.00	60	13.5	80	15.8	100	17.8

Before giving any figures, it is necessary that the mechanical efficiency of all machines be considered the same and conditions standard. The figures in the tables are given in multiples so that missing ones may be readily calculated. For example, 15 B.H.P. is half of 30 and 60 may be found by multiplying 30 by 2, or 20 by 3, etc.

TABLE 8. COST OF GASOLINE IN CENTS TO COMPRESS AND DELIVER 100 CUBIC FEET OF FREE AIR AT 90 POUNDS PRESSURE
Gasoline Consumption One Pint Per Horse Power Per Hour

Brake H. P. to deliver 100 cu. ft. free air per minute	Price of Gasoline Per Gallon—in Cents 8	9	10	11	12	13	14	15
16	.266	.300	.333	.366	.400	.433	.465	.500
18	.300	.337	.375	.413	.450	.487	.525	.562
20	.333	.375	.416	.458	.500	.542	.584	.626
22	.366	.412	.458	.504	.550	.595	.642	.687
24	.400	.450	.500	.550	.600	.650	.700	.750
26	.433	.488	.542	.596	.650	.705	.759	.813
28	.466	.525	.583	.642	.700	.758	.816	.875
30	.500	.563	.625	.688	.750	.813	.875	.938

Example: What will it cost to deliver 1,000 cubic feet of free air at 40 pounds using oil which takes 1 quart per brake horsepower per hour and costs 4 cents per gallon in a compressor rated 22 brake horsepower?

$$\frac{3}{4}\left(\frac{.366}{2} \times 10 \times 2\right) = 2.745 \text{ cents.}$$

TABLE 7. COST OF COAL AT $1.00 PER TON TO COMPRESS AND DELIVER 100 CUBIC FEET OF FREE AIR AT 90 POUNDS PRESSURE

	Weight of Steam in Pounds Required by Engine Per Horse Power Per Hour 24	26	28	30	32	34	36	38	40	42
	Weight of Coal in Pounds Per Horse Power Per Hour When Boiler Evaporates 7 Pounds of Water Per Pound of Coal 3.43	3.714	4.04	4.286	4.571	4.757	5.143	5.428	5.714	6.0
	Cost of Coal Per Horse Power at One Dollar Per Ton—Fraction of Cent .1715	.1857	.2	.2143	.2285	.2378	.2571	.2714	.2857	.3
Brake H. P. to deliver 100 cu. ft. free air per minute	Cost of Coal Per 100 Cubic Feet Free Air—Fractions of Cent									
16	.0457	.0495	.0533	.0572	.0610	.0634	.0686	.0724	.0762	.08
18	.0514	.0557	.06	.0643	.0686	.0714	.0772	.0814	.0857	.09
20	.057	.0619	.0667	.0714	.0762	.0793	.0857	.0904	.0952	.10
22	.0627	.0681	.0733	.0785	.0838	.0872	.0943	.0995	.1047	.11
24	.0684	.0743	.08	.0857	.0914	.0951	.1029	.1085	.1142	.12
26	.0741	.0805	.0866	.0929	.099	.103	.1114	.1175	.1238	.13
28	.0798	.0867	.0933	.10	.1066	.1109	.12	.1266	.1334	.14
30	.0855	.0929	.10	.1071	.1142	.1189	.1285	.1357	.1429	.15

Example: If it takes 20 brake horsepower to deliver 100 cubic feet of free air per minute at 90 pounds pressure, and the compressor is driven by an ordinary steam engine requiring 32 pounds of steam per horsepower hour, and an ordinary boiler evaporating 7 pounds of water per pound of coal, selling at $6 a ton—the coal cost per 100 cubic feet of free air is $0.0762 \times 6 = 0.4572$ of a cent per 100 cubic feet. If the cost is desired for any other pressure, as 40 pounds, refer to table 6. There it will be seen that it takes 16.7 brake horsepower to compress air to 90 pounds and only 12 B.H.P. to compress to 40 pounds. Therefore it will cost $\frac{12}{16} = \frac{3}{4}$ of 0.4572 = 0.3429 of a cent per 100 cubic feet.

In the past few years fuel oil has been used to operate engines for making compressed air. In the following table the cost has been figured on the basis of gasoline. It would be impossible to give a table for all the different grades of fuel oil. If kerosene or other oils are used it will be necessary to know the price per gallon and the consumption per brake horsepower. Multiples of the figures given in the tables will give the cost for any other oil.

In table 6 it is seen that it takes only ¾ as much power to make 40 pounds pressure as 90 pounds. In table 8 it will be seen that 22 brake horsepower at 8 cents costs .366. The cost for 4 cent oil will be .366/2. To compress 1,000 cubic feet is 10 times 100. It takes twice as much oil as gasoline.

Perhaps the commonest way that compressed air is made in the glasshouse is by purchased electric power. The following table gives the cost in cents.

TABLE 9. THE COST OF ELECTRIC CURRENT IN CENTS TO COMPRESS AND DELIVER 100 CUBIC FEET OF FREE AIR AT 90 POUNDS PRESSURE.

Brake H. P. to deliver 100 cu. ft. free air per min.	Price of Electric Current Per KW.-Hour in Cents 1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.
	Per Horsepower Hour in Cents .75	1.125	1.5	1.875	2.25	2.625	3.	3.375	3.75
16	.2	.3	.4	.5	.6	.7	.8	.9	1.0
18	.225	.337	.45	.562	.675	.787	.9	1.012	1.125
20	.25	.375	.5	.625	.75	.875	1.0	1.125	1.25
22	.275	.412	.55	.687	.825	.962	1.1	1.237	1.375
24	.3	.45	.6	.75	.9	1.05	1.2	1.35	1.5
26	.325	.487	.65	.812	.975	1.137	1.3	1.46	1.625
28	.35	.525	.7	.875	1.05	1.225	1.4	1.575	1.75
30	.375	.562	.75	.937	1.125	1.312	1.5	1.687	1.875

The Use of Sillimanite in Glass Works Practice

At a recent meeting at Stourbridge of the Society of Glass Technology, Prof. W. E. S. Turner read a paper on "The Use of Sillimanite in Glass Works Practice." Sillimanite, he said, as reported in the *Pottery Gazette and Glass Trade Review,* had been tested in the laboratories and was now in the process of being tested under practical working conditions in a number of glass works. Experiments were now in hand by several glass manufacturers in regard to sillimanite pots. One set had given surprisingly good results in the preparation of opal fluoride glass, and had already lasted several times as long as the average fireclay pot previously used for the same purpose.

But there was not very much actual works experience yet available to serve as a sufficient guide as to whether sillimanite was going to be an economical proposition so far as pot-made glass was concerned. It was a question, as to whether, with low temperature running, sillimanite presented any very great advantages indeed, he was inclined to think that sillimanite might, under some such conditions, present rather distinct disadvantages, for it was a material which showed up at its best in connection with high temperature firing.

He then referred to a couple of potettes which were inserted into a tank furnace from which glass was being gathered. One of these potettes was of sillimanite and the other of fireclay. The sillimanite potette showed scarcely any signs of wear, whereas in the case of the fireclay potette the lower part had entirely disappeared, whilst the groove round the metal level was very much deeper than in the case of the sillimanite potette. The results of practical tests such as these seemed to show that the sillimanite stood up in contact with glass very much better than did the ordinary fireclay, under commercial conditions where there was a fairly rapid withdrawal of glass through the potette, and, in consequence, a very considerable wash up and down the walls.

But apart from the possible use of sillimanite in actual contact with glass there were cases on record where sillimanite blocks were being used to form the heart or seal of gasports. He had seen a number of these sillimanite blocks in use in more than one furnace. He had seen a number of blocks which had been taken out after having been in use under severe treatment for six months. The temperature of the hearth would certainly not be less than 1,450 deg. C., and although these blocks showed a distinct shrinkage as compared with their size when put in this was probably due to the fact that the material had not been sufficiently fired before being inserted into the furnace. It had been shown by laboratory tests that when mixtures were made up of certain proportions of sillimanite and bonding material—especially ball clay—the shrinkage between 14-15 hundred degs. C. was substantial. With fine grades of sillimanite it might even run to between 6-10 per cent shrinkage between 0 and 1,500 degs.; but the shrinkage was very considerable between 1,400 and 1,500. However, the sillimanite blocks in question, which had been subjected to exceedingly high pressure, had behaved very much better than any of the other ordinary refractory materials had been found to do in connection with previous tests.

One application of sillimanite which had, he thought, been wholly successful was in connection with the covering of the sieges of furnaces. All the reports which had come in so far from the firms who had tried sillimanite for this purpose appeared to be favorable. The material had also been used for damming the flow of glasses both in tube drawing machines and in the flow feeder types of machines, i.e., at the back of the fire hearth of a furnace. Here, again, it had proved very successful. It had also been found suitable in the manufacture of pot rings. When only lightly fired the sillimanite rings had badly disintegrated, but he believed that if only they were fired sufficiently high they would stand up very well to the action of the pot.

Finally, sillimanite should be specifically recommended when used in the form of a slip or paste in the stacks of the regenerator leading the gas and air to ports. This particular use of sillimanite he was keen to introduce in the hope that the life of the regenerator bricks might be increased and so make it possible to put a lining of insulating bricks on the outside of the stack; because there was considerable loss as a rule from such stacks. But it was no use putting an insulating lining around the regenerator stack if the bricks were going to be rapidly corroded away. A slip was made up of sillimanite and ball clay, two parts of sillimanite—one fine and one coarse—to three parts of ball clay. This was then slimed on to the regenerator stacks. When the furnace was pulled out for repairs the stacks were examined, and it was found that the regenerator bricks were absolutely untouched. The lining of sillimanite had prevented any attack whatsoever, and in a few cases it was possible to chip away the sillimanite lining and to leave the end of the brick quite clear, whilst in other cases the sillimanite had bonded on so substantially and thoroughly as to make chipping off impossible. In a few cases, however, it was possible to flake off the sillimanite lining. This meant that the bricks were again available for use, for they were absolutely sound and firm. In the case of a stack where such protection was afforded it might be possible to go still further and to insulate it in order to save heat loss.

During a discussion following the reading of the paper the fact was brought out that sillimanite rings, because of their greater density than ordinary rings, float low in soda-lime glass.

Mr. F. G. Clark advised that sillimanite should never be used in the construction of glass pot into which a salt cake batch was intended to be put. If it were, the sillimanite would be attacked very quickly.

Mr. H. Webb confirmed what Professor Turner had said in regard to the use of sillimanite for the sieges of furnaces. They had, he said, had one of these sillimanite sieges in use for three years.

The Laboratory

The Valuation of Opacifying Materials

Among the materials used in the production of opaque glass, fluorspar and cryolite play an important part. They are used in combination with kaolin and feldspar, and their opacifying action appears to be due to the fluorine which they contain. The determination of this element, therefore, is of importance. Since a small amount of iron tends to give to opaque glass an unsightly greenish color, it is advisable to determine the amount of iron in opacifying materials.

Fluorspar, calcium fluoride, CaF_2, consists of 51.3 per cent calcium and 48.7 per cent fluorine. It often contains impurities. Small amounts of silica, alumina and calcium carbonate are harmless, but the material should be very low in iron.

Cryolite is a sodium-aluminum-fluoride, containing theoretically 32.79 per cent sodium, 12.85 per cent aluminum, and 54.36 per cent fluorine. It has the chemical formula Na_3A1F_6.

Analysis of Fluorspar

The following procedure is based on the extraction of calcium carbonate in the sample with dilute acetic acid, the removal of any silica present with hydrofluoric acid, and the conversion of the remaining calcium fluoride to calcium sulphate by the action of sulphuric acid. The calcium sulphate is calculated to calcium fluoride.

PROCEDURE

Calcium Carbonate. Transfer a one gram sample to a beaker, add 10 cc. dilute acetic acid (1:10), cover with a watch glass and digest on the steam bath for an hour. Remove the watch glass and evaporate to dryness. Add 50 cc. of water, heat to boiling and filter. Wash with hot water, ignite the residue in a weighed platinum crucible at a low heat to constant weight. The loss of weight, minus .0015 gram (the amount of calcium fluoride soluble in acetic acid under the conditions named) is reported as calcium carbonate.

CALCULATION:

$$(\text{Loss in weight} - .0015) \times 100 = \%\ CaCO_3$$

Silica. To the residue in the crucible add 1 gram of yellow mercuric oxide in finely powdered form and mix with the flattened end of a glass rod. Ignite the mixture at a dull heat to constant weight. This converts any sulphides of zinc, lead and iron that may be present to sulphates. Add 2 — 3 cc. hydrofluoric acid and evaporate to dryness. Repeat this treatment twice and finally add a small amount of macerated filter paper, a few drops of hydrofluoric acid and a few drops of ammonia. Evaporate to dryness and ignite at a dull red heat to constant weight. The hydrofluoric acid treatment ensures complete expulsion of silica as SiF_4. The addition of ammonia serves to precipitate the iron. The loss of weight is reported as silica.

CALCULATION:

$$\text{Loss in weight} \times 100 = \%\ SiO_2$$

Calcium Fluoride. Treat the residue from the silica determination with 2 cc. of hydrofluoric acid and 10 cc. of nitric acid, cover the crucible and place on a warm water bath for thirty minutes. Remove the lid and evaporate to dryness; add 2 cc. of hydrofluoric acid and again evaporate to dryness, repeating if the residue is not white.

Add a few drops of hydrofluoric acid and 10 cc. of ammonium citrate reagent; (see below) digest on a steam bath for some time. Filter, wash the residue with a few small portions of hot water containing ammonium citrate reagent; finally wash twice with small portions of water. Ignite the residue, in the tared crucible previously used, to constant weight at a dull red heat and record the final weight.

To the residue in the crucible add 2 cc. of concentrated sulphuric acid and evaporate on a hot plate until fumes of sulphuric acid cease to come off. Repeat twice, using one cc. portions of sulphuric acid. Ignite and weigh as calcium fluoride. An addition of .0022 gram should be made to compensate for loss of CaF_2.

CALCULATION:

$$\frac{\text{Gain in weight} \times 78.07 \times 100}{136.13 - 78.07} + 0.22 = \%\ CaF_2$$

Ammonium acetate-citrate reagent. Dilute 300 cc. of glacial acetic acid in a liter flask with 100 cc. of water; neutralize by careful addition (about 600 cc.) of ammonia (Sp. Gr. 0.90), add 20 grams of citric acid and dilute the solution to 1 liter with water.

DETERMINATION OF IRON. Treat a two gram sample with sulphuric acid to convert the fluorides to sulphates. Leach the residue with hot dilute hydrochloric acid (1: 1) and make an ammonia separation; determine the iron as usual, by dissolving in hydrochloric acid and subsequent titration with permanganate.

Analysis of Cryolite

DETERMINATION OF FLUORINE. The following procedure is based on the evolution of fluorine by means of perchloric acid, with subsequent absorption and gravimetric determination.

1. Transfer a one gram sample, powdered to pass a 200 mesh sieve, to a platinum crucible, fitted with a Pyrex glass still head, as shown in the sketch.

2. Support the crucible in an oil bath, adjust the still head and pass the delivery tube to the bottom of a 250 cc. Erlenmeyer flask containing 25 cc. of 20% solution of sodium hydroxide, diluted to 150 cc. Place in the second absorption flask 100 cc. of a 1% solution of sodium hydroxide and 1 cc. of phenolphthalein.

3. Aspirate a stream of air rapidly through the apparatus, add 10 cc. of perchloric acid to sample in the crucible.

4. Heat the oil bath to a temperature of 210 degrees C. for about 45 minutes, increase the temperature to 250 de-

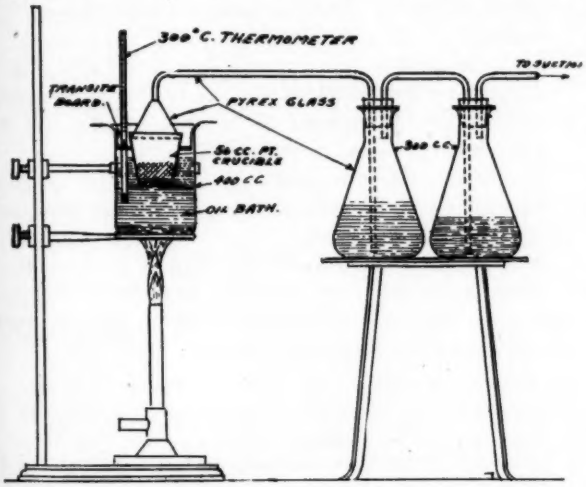
grees and continue the aspiration of air until the white fumes of perchloric acid cease to be given off.

5. Remove the crucible from the bath and after a few minutes add 5 cc. of perchloric acid and repeat the operation.

6. Remove the crucible from the bath and add 50 cc. of water. Agitate to dissolve the perchlorates. Filter through a paper and wash with water. The filtrate may be used in the determination of iron, aluminum, calcium and magnesium.

7. Place the filter paper in the crucible and burn the paper. Replace the crucible in the oil bath, add 5 cc. of perchloric acid and 15 cc. of water and repeat the distillation as in 4.

8. Transfer the sodium hydroxide solutions from the absorption flasks to a 2,000 cc. beaker and neutralize with



formic acid, add 10 cc. of formic acid in excess and add 1,500 cc. lead chloride solution.

9. Allow the precipitate of lead chlorofluoride to settle, filter on a tared Gooch crucible, remove as much lead chloride solution as possible with suction, then wash with a fine stream of water, using not more than 10 cc.

10. Dry the precipitate at 130-150 degrees C. and weigh as PbFC1.

CALCULATION:

$$\frac{\text{Weight of PbFC1} \times .07261 \times 100}{\text{Weight of sample}} = \%\ \text{F}$$

DETERMINATION OF IRON AND ALUMINUM IN CRYOLITE. To the filtrate obtained in the distillation procedure of fluorine (step No. 6) add ammonia in slight excess and filter. Dissolve the precipitate on the filter in hot dilute hydrochloric acid (1:1), and reprecipitate the iron and aluminum with ammonia, taking care not to use an excess, which would dissolve some aluminum and cause the results to be too low. Wash the precipitate well with hot water, ignite and weigh.

CALCULATION:

$$\frac{\text{Weight of } Al_2O_3 + Fe_2O_3 \times 100}{\text{Weight of Sample}} = \%\ Fe_2O_3,\ Al_2O_3$$

The iron in the precipitate is determined in the usual manner, and the amount of aluminum is found by difference.

Factors: $Fe \times 1.4298 = Fe_2O_3$. $Al_2O_3 \times 0.5303 = Al$

Ornamental and Art Glass Industry of the Iser Mountains

BY DR. WILHELM HANNICH*

Out of the established forms of the old art glass craft a special branch of industry has grown up in the Iser Mountains, Czechoslovakia, which can be designated under the name of ornamental and art glass industry. The decorative sense which was displayed in the old glass bowls that are now being preserved in museums has been developed further and has been applied to other different objects. Besides painting and engraving, various decorative effects have been obtained by the use of colored glass, applied to glass objects, and in this way a new method of working has been evolved. At the present time whole objects are made from woven and spun colored glass "over the lamp" as is the expression used in the mountains.

The workman uses small glass rods, about four millimeters in thickness, which are heated simultaneously, and from which the various decorative objects formed are used as jewelry or in the home. Much skill, artistic sense and imagination are required to do this kind of work successfully.

Numerous art glass makers are engaged in the production of small crystalline imitations of precious stones. These almost equal the genuine stones in luster and color. They serve to decorate rings, brooches, hatpins and so forth. Much of this work is done at present by machinery.

A part of this ornamental glassware is made from so-called bulb glass. This ware is made in glass factories by blowing large round glass bulbs in all kinds of colors, which are then broken up. From the single pieces parts for definite purposes are cut.

Pearl colored glass is used for brooches, pendants for watch chains, and so forth.

The method of manufacture depends on the demands of fashion and the taste of the buying public. Novelty is always sought after and the general demand is followed. This business is greatly dependent upon season and fashion. The producer is never certain how long his work will last until glass is again pushed into the background and must make way for other articles of fashion. Here the artistic and decorative sense becomes important. Decorative glass ware always comes on the market singly, and must excite the interest of the buyer. If the arrangement, the workmanship and the execution is not of such quality as to impress the buyer, the opposite effect is obtained and, as in every other work of art, it becomes ridiculous.

Although the demands made on the skill of the workman and the artistic sense of the manufacturer are very high, yet the reward for his trouble is often small. If a manufacturer does not exactly gauge the taste of the buying public, the high cost of manufacturing is usually lost. As is the case with all articles of fashion, profits can only be made for a short time, while the demand is ascendant. If the manufacturer tries to increase his profits at the expense of the quality of his wares, as is often the case with other glass articles, his product loses immediately in appearance and is no longer bought.

* Friedrichswald near Gablonz, Czechoslovakia.

Selecting Speed Reducers of Proper Capacity

The increasing use of speed reducers in place of chain drives or open gearing, for driving mechanisms of lehr and belt conveyors and for various other purposes in the glass factory gives a special value to the practical and theoretical information on speed reduction problems given for plant executives and engineers in this timely article.

By Francis A. Emmons*

One of the interesting developments in power transmission during the last few years has been the rapid growth in the use of unit speed reducers and their applications to varied forms of machinery and industrial equipment.

A good deal has been written on this subject in regard to design, features, principles of operation, and construction of the different types and the advantages of unit speed reducers as compared with other forms of speed reduction equipment such as belts and pulleys, chains and rope drives, open gearing, etc.

We believe, however, that to the engineer or plant executive, it is of even greater importance to have fundamental information covering the application of these machines to various forms of equipment with basic formulæ and practical problems which will enable him to figure on specific jobs and aid in selecting machines of proper type and capacity and reduction ratios.

It is with this thought in mind that the present article on spur gear speed reducer calculations has been prepared. The information presented is applicable to any of the standard types of spur gear reducers now on the market, including the plain, spur, planetary and non-planetary types, also the herringbone type. Worm gear reducer problems require a little different handling.

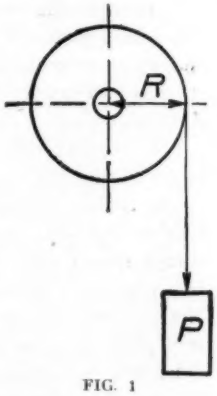


FIG. 1

It is hoped that the information will prove interesting and helpful to those who are concerned with transmission and speed reduction problems.

The principal point to be remembered in dealing with speed reduction problems is that theoretically the same horsepower is delivered by the reducing unit as is delivered to it by the prime mover. The speed, however, decreases through the reducer—depending upon the reduction ratio used, and the torque or twisting moment correspondingly increases.

It is necessary to have a clear understanding of this subject in order to make a proper selection of speed reducers to meet a given set of conditions.

We are defining below the various elements which are factors in all speed reduction problems.

P = Load in pounds.
R = Radius in inches of drum or pulley.
$2\pi R$ = Circumference of drum or pulley.
N = Revolutions per minute (R.P.M.)
T = Torque or twisting moment in inch pounds.
W = Work done.
HP = Horsepower (33,000 ft. lbs. per min.)

Torque or twisting moment is that force which tends to produce rotation in a shaft or pulley and is equal to the product of the force exerted times the length of the lever arm.

Thus referring to Fig. 1.

$$T = P \times R \quad (1)$$

Now work done is equal to the product of the force acting on an object times the distance through which it moves.

Where D = Distance travelled

$$W = FD \quad (2)$$

The distance through which the force acts in one revolution is equal to the circumference of the circle which is $2\pi R$.

Therefore, work done in one revolution

$$W = P \times 2\pi R \text{ inch pounds} \quad (3)$$

Now if the drum or pulley makes more than one revolution the total work done will be

$$W = P \times 2\pi R \times N \text{ inch pounds} \quad (4)$$

Since one horsepower is equivalent to 33,000 ft. lbs. per minute the horsepower required to revolve the pulley N times per minute against the weight P will be

$$HP = \frac{P \times 2\pi R \times N}{33{,}000 \times 12} \quad (5)$$

Other useful formulae are derived from equations No. 1 and No. 5 as follows:

$$HP = \frac{2\pi R \times P \times N}{33{,}000 \times 12} \quad (5)$$

$$HP = \frac{T \times N}{63{,}025} \quad (6)$$

$$T = \frac{63{,}025 \times HP}{N} \quad (7)$$

$$T = P \times R \quad (1)$$

$$P = \frac{T}{R} \quad (8)$$

$$R = \frac{T}{P} \quad (9)$$

By using one or more of the above formulae it is possible to solve any speed reduction problem which may be presented, the method being indicated in the simple problems which follow:

Let it be borne in mind, however, that in actual practice, the efficiency of both the reducer and the driven machine must be considered, when selecting reducers of the proper size.

Practical Application of Formulae on Spur Gear Speed Reducers

(1) If we have a drum with a radius of 12 inches and a load of 2,000 lbs. to be moved find the torque necessary to move it.

*Foote Bros. Gear & Machine Co., Chicago, Ill.

(1) $T = P \times R = 12 \times 2{,}000 = 24{,}000$ inch pounds torque.

(2) If the drum is to be driven at 1 R.P.M. how much work will be done during one revolution?

(10) $W = 2\pi TN = 6.28 \times 24{,}000 \times 1 = 150{,}720$ inch pounds.

(3) How much horsepower will be required to drive the above drum at 20 R.P.M.?

(3) $$HP = \frac{2\pi R \times P \times N}{33{,}000 \times 12} = \frac{6.28 \times 12 \times 2{,}000 \times 20}{33{,}000 \times 12}$$

$= 7.61$ H. P.

(4) If we know that the torque on the drum shaft is 24,000 inch pounds, what H.P. would be required to drive it at 20 R.P.M.?

(6) $$HP = \frac{T \times N}{63{,}025} = \frac{24{,}000 \times 20}{63{,}025} = 7.61 \text{ H. P.}$$

(5) If 7.61 H.P. is required to drive this drum at 20 R.P.M. what is the torque in inch pounds on the center of the drum shaft?

(7) $$T = \frac{62{,}025 \times HP}{N} = \frac{63{,}025 \times 7.61}{20} = 24{,}000 \text{ inch}$$

pounds torque.

(6) If the torque or twisting moment at standing load is 24,000 inch pounds and radius of drum is 12 inches, what is the load on the drum in pounds?

(8) $$P = \frac{T}{R} = \frac{24{,}000}{12} = 2{,}000 \text{ lbs.}$$

(7) If the torque on this drum shaft is 24,000 inch pounds and the load on the drum is 2,000 lbs., what is the radius of the drum?

(9) $$R = \frac{T}{P} = \frac{24{,}000}{2{,}000} = 12 \text{ inch radius or } 24'' \text{ diam.}$$

Importance of Torque Determination

We cannot overestimate the importance of carefully calculating actual torques on the driven unit, as a basis of determining horsepower required to move the load. This is particularly true in cases where high reduction ratios are used—where the final speed is only a fraction of a revolution per minute.

The capacity of the driving unit must always be great enough to compensate for frictional and other losses in the reducing unit and driven unit, also to start the load on the driven unit, even though the power required while running is much less.

Selection of Reducer of Proper Size

We will now assume the conditions for a problem and carry the calculation clear through to the selection of the proper size and type of speed reducer to do the work.

Assume that we have a conveyor whose efficiency is 80 per cent. The head shaft of this conveyor is to be driven by a spur gear speed reducer at a speed of 25 R. P. M. and the total load to be moved is 4,000 pounds. Radius of sprockets driving conveyor belt is 18 inches, speed of driving motor 800 R. P. M.

From Formulae (5)

$$HP = \frac{2\pi R \times P \times N}{33{,}000 \times 12} = \frac{6.28 \times 18 \times 4{,}000 \times 25}{33{,}000 \times 12} =$$

28.54 H.P.

As the efficiency of the conveyor is 80 per cent the actual H.P. required will be

$$28.54 \times 120\% = 34.25 \text{ H. P.}$$

As the efficiency of the reducer is 95 per cent the size of motor required will be

$$34.25 \times 105\% = 35.96 \text{ H. P.}$$

The reduction ratio is 800 to 25 or 35 to 1.

All that is now necessary is to select from manufacturers' catalogs a machine of rating and ratio conforming to the above results. In case of doubt, or when an especially difficult problem is under consideration, it is advisable to consult the engineering department of the manufacturer.

The information given above is all in practically every day use in the Foote Brothers Gear & Machine Company engineering department and it is hoped that it will assist engineers and executives to dispel the uncertainties and doubts that have tended in the past to make more or less of a mystery of this important subject.

Glass Wool as Insulator for Refrigeration*

By H. C. BATES, Corning, N. Y.

Glass wool has a number of properties which should make it desirable as a heat insulator. It is light, is proof against fire and dampness, chemicals, rodents, etc., will stand high temperature, will not decay or deteriorate with use and has low specific heat. Since the thermal conductivity of this material has not been compared to that of the materials under identical conditions at temperatures low enough for refrigerating purposes, an investigation covering this point was undertaken.

The method employed consisted in determining the rate at which ice melted in a container insulated with the various materials.

The results are contained in the following table, values obtained by other experimenters are given for comparison.

TABLE

Material	*Density* grs/cm	*K (obs.)* C. G. S. U.	*K.* (tables)
Glass Wool	0.133	10.9×10^{-5}	7.5×10^{-5}
Cork (Powdered)	0.140	11.4	10.4 11.2 10.6
Magnesia-Asbestos composition	0.340	16.0	15.0 16.0
Slag Wool	0.247	10.8	10.4
Sil-o-cel (Powder)	0.147	12.5	12.0
Cotton Waste	0.128	13.3	13.1
Wool (Sheeps)	0.073	8.4	8.4 9.2 8.5

The values in the table show that glass wool compares favorably with the best insulators available for refrigeration purposes.

*Abstract of paper presented at the annual meeting of the American Ceramic Society at Atlanta, Ga.

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Wanted: A New Glass at a Low Price

The recent anthracite coal strike has brought forcibly to the attention of the inhabitants of Eastern cities the value of sunshine to the welfare and happiness of mankind. Deplorable as has been the effect of the conflict between miners and operators on economic conditions, the indirect damage done to life and health has been infinitely more serious. There cannot be any doubt but that the prevalence of many forms of illness in the cities on the Eastern seaboard during the past winter has been caused by the enforced depravation of sunshine by smoke due to the use of soft coal.

It has only recently been recognized by physiologists that the beneficial effects of sunshine are not so much owing to the visible sun rays as to the small percentage of rays having a wave length so small as to render them invisible to the human eye. These ultraviolet rays, which according to investigators constitute less than one per cent of the total sunlight, appear to be essential to the normal development of plant and animal life. Not only do they occur in small quantity, they are also of feeble strength and penetrating power, and are most easily absorbed by fog, vapor and smoke, so that any sunlight reaching the cities through an atmosphere of smoke loses its efficacy and arrives in a devitalized condition.

The ever increasing size of apartment houses and office buildings of the American cities has deprived the majority of the urban population of "their place in the sun." Even in the towns of smaller size the twelve story apartment house is becoming a familiar sight. In the measure that architects and builders realize that the new conditions demand new conceptions in architecture, the use of brick and terra cotta in the construction of steel buildings will be replaced by glass.

Walls do no longer play any part in the support of buildings. There is every reason why the steel framework of buildings should be filled in by transparent instead of dark material. That this has not been done to any great extent is due to the fact that evolution in architecture is a difficult and slow process.

Ordinary plate and window glass, unfortunately, absorbs the greater part of the ultraviolet rays and allows only that portion to pass that has the largest wave length and the least potency. This fact is a challenge to the flat glass industry to produce glass that will transmit all, or at least the greater part of the ultraviolet radiations, without being prohibitive in price.

Such glass would make the cities a healthier place to live in and would decrease the death rate caused by respiratory and pulmonary diseases which take such a heavy toll of human life at the end of every winter in the northern states. A most insistent demand for such glass is already being made by hospital authorities, who years ago have known the curative properties of sunshine, before the scientific world realized that only a small part of the sunlight is active.

That the solution of this problem is only a question of time and insistence of demand is the firm belief of those who have witnessed that in the majority of cases, science has been able to fill any such need, and fill it satisfactorily.

"Some Day You Will Tax It"

To American industry by far the most important news of the past month has been the announcement of the formation of the National Research Endowment, headed by Herbert Hoover, Elihu Root, Charles E. Hughes and associates to aid American universities in carrying on fundamental research. This fund is being collected since it is becoming increasingly evident that fundamental research at the majority of our universities is being pushed into the background. The facts are that our institutions of higher learning are being deprived of their most promising men by industrial concerns, who desire their services in the field of applied science, and by the pressure of teaching duties upon those whose superior abilities would enable them to pursue original research.

That many of our larger universities have gradually grown into educational mills, as thoroughly standardized as a Ford automobile assembling plant, is no secret to their graduates. In the development of the modern university the emphasis is placed on buildings, equipment, stadiums and athletics, rather than on research and scholarship. Consequently, while America leads the world in applied science, it lags behind smaller nations, unable to afford any such equipment as that with which our institutions are provided, which yet have produced men who have changed the trend of civilization.

We are an intensely practical nation, and our attitude of mind is such that we are interested mainly in research that will yield immediate profits. Pure science, which cannot always show direct relations to practical application, has been neglected in comparison.

Every increase in wealth and comfort available to-day has been due to the discovery of some abstract truth that has at first been appraised as trivial and of slight value to the world. The development of the modern organic chemical industry is based on Kekule's conception of the benzene ring. The work of Pasteur has found its starting point in the theory of the asymmetric carbon atom. Maxwell's mathematical deductions are the basis of present day radio development.

"What good is it?" asked a member of Parliament of Faraday, the discoverer of electrical induction, when the inventor demonstrated his first transformer. "Some day you will tax it," was the reply. Nothing could be more certain than the return on the investment of capital in pure scientific research. It will pay for itself a hundred fold, even as Faraday's transformer has grown into the mighty electrical power development of the present day.

Technical Consultation Service

QUESTION 92. GLASS BATCH. I have never made use of the Consultation Service of your journal although I have been a reader since the first issue.

The following is a glass batch that I came into contact with recently on which I would like your comments.

Sand	1,200	Pounds
Soda	450	"
Lime stone	245	"
Salt cake	5	"
Arsenic	24	Ounces
Decolorizer mixture	2	"

and four pounds of the following mixture:

Calcium sulphate	35	Pounds
Salt cake	35	"
Barium sulphate	30	"

Why in the world would anyone put sulphates into good glass, least of all plaster of paris. I find no carbon used in any form. Also why put barium into common commercial bottle glass.

I understand that these people get a ton of glass from only seven and one half square feet melting area. At present they are having a siege of devitrified and cordy glass on their gallon shop where the glass is cooled somewhat before feeding. It does not appear on the smaller shops. Does the above mixture account for the bad glass or for the large tonnage?

I suggested that they use feldspar instead of this mixture. How much would you suggest for a start?

ANSWER: We cannot find much wrong with the proportions of this batch. It is our opinion, however, that the addition of the four pounds of a mixture of calcium sulphate salt cake and barium sulphate is perfectly useless although there probably is no harm in this practice. It is merely a loss of time and material.

Assuming that the raw materials are reasonably pure, the glass made as per formula mentioned will have the following compositions:

Silica (SiO_2)	74.90%
Sodium oxide (Na_2O)	16.55%
Calcium oxide (CaO)	8.55%

We believe that it would be better to produce a glass somewhat lower in lime and higher in sodium oxide. This would be in accord with the best practice. It is therefore suggested to change the batch formula as follows:

Sand	1,150 lbs.
Soda ash	450 "
Limestone	220 "
Salt cake	5 "

This batch will give a glass of the following composition:

Silica (SiO_2)	74.90%
Sodium oxide (Na_2O)	17.29%
Calcium oxide (CaO)	7.91%

The devitrification which you mention in your letter is probably caused by the fact that the glass has to be cooled somewhat before feeding. Such a condition is apt to cause this trouble, especially in a glass high in silica. We agree with you that the use of feldspar may be helpful to overcome this condition, and would suggest the use of 10 pounds per 1,150 pounds of sand as a start.

It is always a difficult matter to give advice about a batch when the composition of the raw materials is unknown. We trust that this will be taken into consideration.

To avoid devitrification the glass should be fed as soon as possible and be cooled quickly through the dangerous temperature range in which devitrification is likely to take place. Since as you say there is no devitrification in the other shops, it is merely a question of proper handling and not so much due to faulty composition of the glass.—J. B. K.

Bureau of Standards Lists Publications on Glass

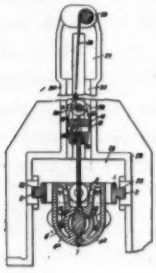
The Bureau of Standards, Dr. George K. Burgess, director, Washington, D. C., is issuing Letter Circular LC 131, giving a list of the publications of the Bureau relating to glass and to refractories and other ceramics. The list includes scientific papers, technological papers, circulars, Federal specifications, simplified practice recommendations, building code committee reports, and Bureau of Standards publications which have appeared in the *Transactions* and the *Journal of the American Ceramic Society*.

Recent Patents

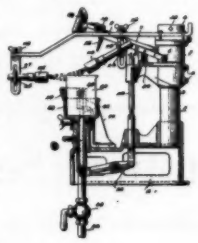
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

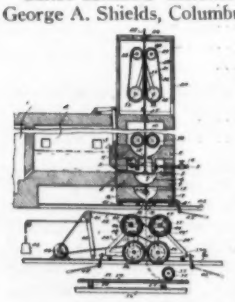
MANUFACTURE OF GLASSWARE. U. S. 1,578,442. March 30, 1926. August Kadow, Toledo, O., assignor to the Libbey Glass Manufacturing Co. Filed 3/27/22. This invention relates particularly to the manufacture of sheet glass by drawing the same from a gathered mass of molten glass. The method consists in gathering from a source of supply a quantity of molten glass by suction action into a gathering head having a restricted outlet passage, removing the charged gathering head from the source of supply, and then drawing the glass while still soft from the gathering head through the outlet passage to stretch it into predetermined shape, the gathering glass having a portion anchored to the gathering head.



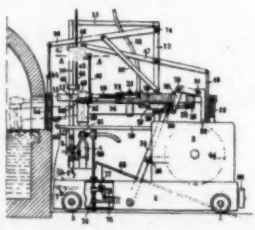
APPARATUS FOR SHAPING GLASS ARTICLES. U. S. 1,578,427. March 30, 1926. David E. Gray, Harry R. Boals and James Bailey, Corning, N. Y., assignors to Corning Glass Works. Filed 12/10/23. Means for altering the shape of a desired portion or portions of articles which have been given a preliminary shape, means for holding the article while it is being operated on, means for heating the article to permit the shaping, means for bringing a shaping member into co-operative relation with the article, coacting shaping means for imparting the configuration of the shaping member to the heated portion of the article, and a common means for controlling the heating means and the shaping means.



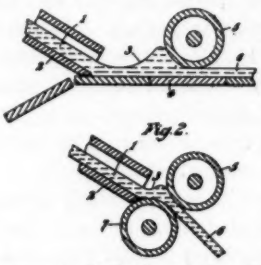
GLASS-MAKING MACHINE. U. S. 1,578,926. March 30, 1926. George A. Shields, Columbus, O. Filed 2/19/23. In a glass machine, a communicating drawing and flow chamber, means for drawing continuous glass sheets upwardly from the flow chamber through the drawing chamber, an elevating mechanism located above the drawing chamber for moving the sheet glass from the drawing chamber, means for separating the flow and supplemental chambers to permit glass to flow downwardly when the drawing operation has ceased, and a plurality of laterally adjustable rollers below the supplemental.



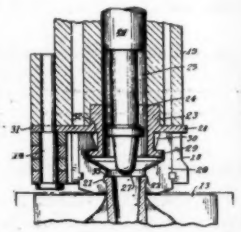
AUTOMATIC MACHINE FOR MANUFACTURING BLOWN-GLASS ARTICLES. U. S. 1,579,396. April 6, 1926. Emile Roirant, Paris, France, assignor to Société Anonyme D'Etudes et De Constructions D'Appareils Mecaniques Pour La Verrerie. Filed 3/20/24. The machine, the construction of which is claimed to be much more simple than that of machines hitherto constructed or proposed and the output of which is greater, offers, according to the inventor, the essential advantage, that it may be employed with all kinds of existing furnaces. Further, it is claimed, that it may be stopped or put out of work instantly during any period, short or prolonged, without its stoppage and its later resumption of work influencing or modifying in any manner the working of the furnace by which it is fed and without any other action than its arrest or its putting into action again. The parison mold is operated by mechanism permitting it to suck up the glass directly in the furnace without any anti-chamber.



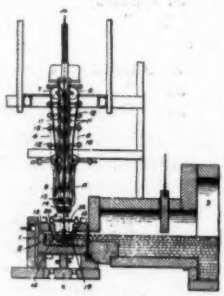
PRODUCTION OF CONTINUOUS STRIPS OF GLASS AND APPARATUS THEREFOR. U. S. 1,579,825. April 6, 1926. Ernest Britow Le Mare, St. Helens, England, assignor to Pilkington Bros., Ltd. Filed 9/16/24. Process of producing a continuous strip of glass consisting in forming a pool of molten metal leading to a pass which forms the strip, the pass dimensions being substantially equal to the thickness of the strip and greater than the width of the strip, characterized by the pool being unconfined in respect to its edges up to and through the pass, but confined in respect to its back end, for the purpose of diminishing the surface of glass exposed to cooling action of the air and eliminating the need of special heating means.



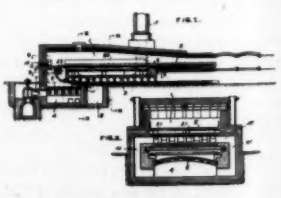
MACHINE FOR BLOWING GLASS ARTICLES. U. S. 1,578,400. March 30, 1926. Albert N. Cramer, Toledo, O., assignor to the Owens Bottle Company. Filed 11/21/23. Means for preventing or reducing to negligible amount excessive leakage of the air supplied through the adapter to the neck mold for blowing the glass so that a full line pressure may be maintained at the blowing point and waste of air under pressure avoided. Means to insure accurate alignment of the thimble sections and thus avoid the defect in the finished ware produced when one mold section is offset with respect to the other. Means to prevent the corners of the thimble sections from dragging on the neck of the bottle as said sections open, which dragging causes rapid wear of the mold.



APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,580,150. Apr. 13, 1926. Robert A. Miller, Jr., Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 5/9/23. In glass drawing apparatus employing a glass bath from which a sheet of glass is to be drawn, a refractory member provided with a slot lying in the glass, a metal member having a slot portion lying in the bath above the slot in the refractory member with the sides of said slot portion, over which the sides of the glass sheet are drawn, roughened, and covered with a thin coating of hardened glass, and means for cooling the portion of the metal slot member in contact with the glass.

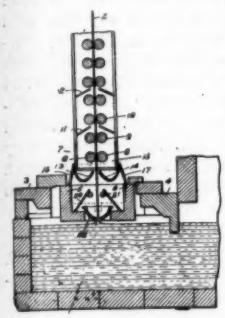


LEHR FOR GLASSWARE AND OTHER ARTICLES. U. S. 1,578,792. March 30, 1926. Walter O. Amsler, Toledo, O. Filed 4/1/25. It is with the maintenance of the requisite elevated temperature at the intake end of the annealing chamber that this invention has primarily to do. Through a devious passageway the conveyor enters the annealing chamber at the charging end; and as it enters and before it reaches the place where it receives its burden of ware to be treated, it has already been heated to a temperature approximating that of the introduced ware.



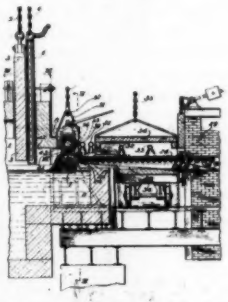
Within the annealing chamber proper and along the bases of the side walls, beyond the conveyor, but spaced at an interval from the walls, are shield plates, which serve to confine the cooler currents, to prevent them from sweeping directly upon the ware, but rather to cause them to flow to the floor beneath the conveyor. There the air is heated again, and a counter-current of hot air rises through the conveyor.

APPARATUS FOR MAKING SHEET GLASS. U. S. 1,580,140. Apr. 13, 1926. Walter G. Koupal, Mt. Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 8/12/25.



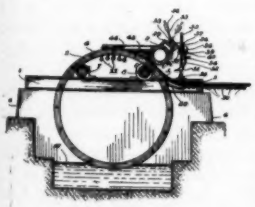
In combination with apparatus arranged to draw a glass sheet from an open pool of molten glass, and closure means surrounding the space above the pool through which the sheet is drawn, of means for preventing inward movement of the edge of the sheet in said pool comprising a shielding plate of dish shape, with its convex side down, spaced above the surface of the pool, but closely adjacent thereto and having a slot extending inward from its edge and fitting around the edge of the sheet, cooling means extending down into the plate adjacent the sides of the said slot, and means for supplying a cooling fluid thereto.

APPARATUS FOR MAKING PLATE GLASS. U. S. 1,580,130. Apr. 13, 1926. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 7/9/25.



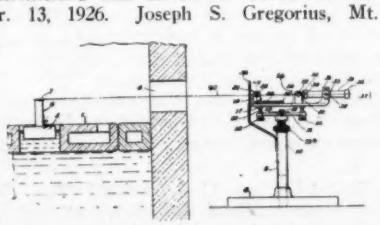
In combination, a glass tank having a forehearth or extension having an open top, a pair of horizontal driven and cooled sizing rolls arranged one above the other in said open top with the lower roll partially immersed in the molten glass in the forehearth, and a glass receiving bed extending laterally from a point adjacent the pass between the rolls for carrying away the glass which is formed, the lower roll being located with its axle above the level of the glass in the forehearth and with its ends lying just inside the inner faces of the side walls of the forehearth.

APPARATUS FOR MAKING SHEET GLASS. U. S. 1,579,666. April 6, 1926. Lee Showers, Charleroi, Pa., assignor to Pittsburgh Plate Glass Co. Filed 7/9/25.



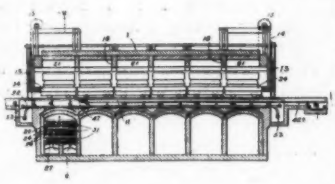
Apparatus for making sheet glass in ribbon form by a combined pouring and rolling operation. The roll corresponds in function to the ordinary casting table employed in a plate casting operation, the glass being rolled out to proper thickness by a sizing roll mounted in fixed position over the large roll, which latter is caused to revolve slowly so that it moves with the glass as it passes beneath the sizing roll.

APPARATUS FOR MAINTAINING THE LEVEL IN GLASS TANKS. U. S. 1,580,135. Apr. 13, 1926. Joseph S. Gregorius, Mt. Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 12/3/24.



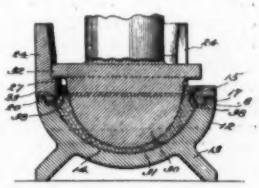
The apparatus comprises a refractory float located in the glass batch in position to be observed through an opening in the side wall of the tank, and a sighting device located outside the tank, by means of which the vertical level of the float in the tank may be determined. This sighting device preferably having in one end a colored glass to protect the eye of the observer from the intense light and heat may be constructed in various ways, but in its simplest form it comprises a leveling device carrying a pair of spaced sighting wires, and a scale past which the line of sight extends, so that the observer in lining up the two wires with a mark upon the float can also see the scale and in this way determine the vertical position of the float.

APPARATUS FOR MAKING PLATE GLASS. U. S. 1,580,122. Apr. 13, 1922. Albert E. Evans, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 6/5/24.



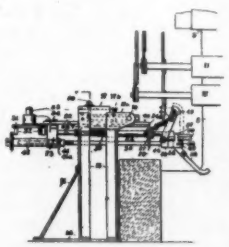
The period of time required between the removal of the pot from the melting furnace and the pouring operation necessitates the skimming of the pot in all instances because of the cold skin which is formed at the surface. The present device avoids these difficulties by providing a secondary furnace adjacent the casting table in which the pots are placed as they are brought from the melting furnace, and in which the glass in the pots can be brought to a definite and uniform temperature preliminary to pouring.

METHOD OF PRESSING GLASS. U. S. 1,578,448. March 30, 1926. States Lee Lebby, Corning, N. Y. Filed 7/16/25.



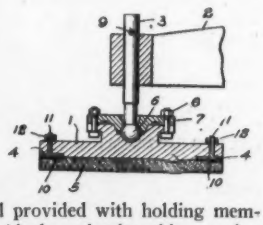
The principal object is to provide a method of pressing glass which will prevent "suck" in the finished blank, i. e., will prevent contraction of the pressed surfaces of the blank, as it cools, away from the mold surfaces, and to provide a method of pressing glass which will eliminate the matted appearance of the pressed surfaces. These objects, the inventor states, are accomplished by making good the contraction in volume of the blank, by flow of glass from a zone which forms no part of the effective pressed surfaces of the blank, and which is free of contact with any part of the blank forming mechanism, and hence unchilled.

EDGE-HOLDING DEVICE FOR SHEET GLASS. U. S. 1,580,128. Apr. 13, 1926. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 5/2/24.



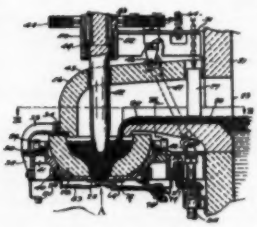
In combination with apparatus for drawing a glass sheet from a molten bath, means for preventing inward movement of the edge of the sheet comprising a pair of fingers spaced apart so that they will straddle the edge of the sheet, and pivoted opposite the edge of the sheet, and mechanism for swinging the fingers at intervals about their pivot so that they move downward along the edge of the sheet and into the tapering base thereof to thin it and then back from such position along substantially the same path.

POLISHING RUNNER. U. S. 1,580,129. Apr. 13, 1926. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 6/16/23.

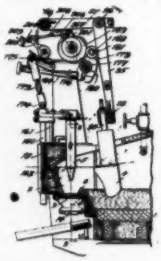


In combination, a plate glass polishing runner comprising a supporting block, recessed on the lower face at the edge thereof, a sheet of polishing felt on the lower face of the block, and means for securing the felt to the block consisting of means cemented to the upper surface of the felt sheet and adapted to fit into the recessed lower face of the block and provided with holding members extending upwardly through the block, and releasable securing means for the upper ends of said members.

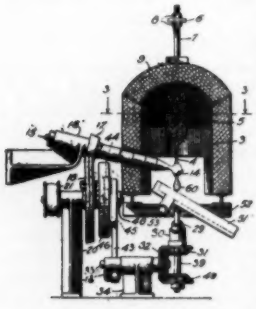
APPARATUS FOR DELIVERING CHARGES OF MOLTEN GLASS. U. S. 1,574,709. Feb. 23, 1926. Leonard D. Soubier, Toledo, O., assignor to the Owens Bottle Co. Filed 12/20/26. An object of the invention is to overcome tendency for the glass at the side of the regulator next to the furnace to flow more freely through the discharge outlet than the glass on the side of the regulator remote from the furnace which has a more circuitous path and is subject to greater cooling influences and for this purpose means are provided for causing a rotary movement of either the receptacle, into which the glass flows from the furnace, or the regulator, or both, whereby a one sided cooling is prevented and a symmetrical flow is obtained.



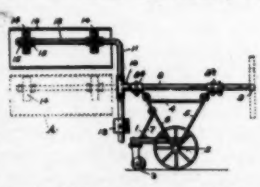
FEEDING MOLTEN GLASS. U. S. 1,573,742. Feb. 16, 1926. Karl E. Peiler, Hartford, Conn., assignor to Hartford-Fairmont Co. Filed 11/25/25. Erroneously issued to Hartford-Fairmont Company, should have been issued to Hartford-Empire Company, of Hartford, Connecticut, to whom it was assigned. This application is filed for the purpose of claiming an important advance in the glass feeding art which has been given the name of "phase-changing," meaning change in the relative time of occurrence of the operations controlling the formation of the mold charges, ready for severing, and the operation of severing these mold charges, as these operations are repeated in successive cycles. The later developed form of the invention herein claimed contemplate, in combination with the phase change, lifting the stud of glass left after each severing operation at a variable time in respect to the time of severing, in order to shape the lower end of the stub of glass left above the severing plane and to thus shape the lower end of the next succeeding charge.



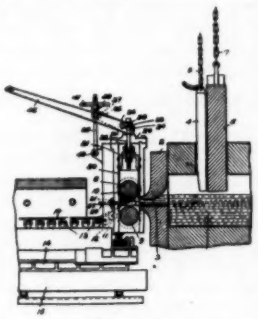
FEEDER FOR MOLDS. U. S. 1,574,736. Feb. 23, 1926. Karl E. Peiler, Hartford, Conn., assignor, by mesne assignments, to Hartford-Empire Co. Filed 8/3/12. In the operation of this feeder, the stream of molten glass flowing against or upon the revolving surface of the head and flowing thence sidewise toward the polar portions of the head is thus wound around and distributed over the surface and accumulates thereon. When a sufficient amount of molten glass has thus been accumulated by the head, its rotation is slackened or stopped and the glass at once begins to sag downwardly, the greater portion of the glass thereon forming a pear shaped drop. Shears sever the attenuated neck at regular intervals and thus separate the drop from the portion above it, the drop falling into or upon the chute, or being otherwise taken care of, as may be desired.



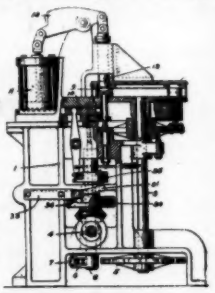
GLASS-CYLINDER-HANDLING TRUCK. U. S. 1,580,188. Apr. 13, 1926. Uriah O. Wright and Charles H. Wright, Clarksburg, W. Va., assignors to Pittsburgh Plate Glass Co. Filed 8/21/24. In combination in a truck for carrying glass cylinder sections, a body provided with wheels, a horizontal operating shaft journalled for rotation in the body, and carrying at one end a transverse bar, one end of which is directed at right angles to said bar and the other end of which is counterweighted, non-scratching roller means on the first mentioned end of the rod for engaging the interior of the cylinder sections, and a handle for turning said shaft.



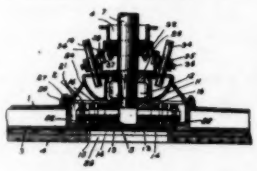
PROCESS AND APPARATUS FOR ROLLING GLASS. U. S. 1,580,156. Apr. 13, 1926. Grover C. Oakes, Creighton, Pa., assignor to Pittsburgh Plate Glass Co. Filed 7/9/25. "Flushing" the rolls is accomplished by periodically separating the rolls for short periods, during which periods, the glass flows through the roll pass in a thick stream carrying with it any accumulation of bubbles and also washing away any layer of more viscous glass which may have been accumulating along the clay surfaces just back of the rolls. This flushing operation may be carried out every hour or two and ordinarily the rolls will be separated about one half inch, while a body of glass from eight to twelve inches long flows through, which would eventually enter into and be scattered through the ribbon if not collected in this manner.



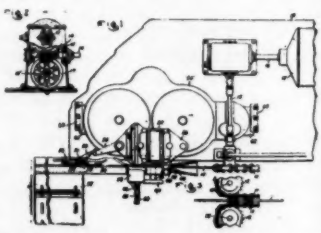
APPARATUS FOR FORMING OPTICAL BLANKS. U. S. 1,580,159. Apr. 13, 1926. William Owen, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 5/13/24. The combination with a tunnel heating chamber provided with a continuous carrier for optical blanks, and a molding or pressing machine adjacent the exit end of the chamber provided with mold cavities and plunger means for pressing the blanks in such cavities, of transfer means intermediate the carrier and the pressing machine, and means for discharging the blanks from the carrier to the transfer means comprising, a driven endless pusher member provided at intervals with blank engaging devices.



SURFACING MACHINE. U. S. 1,580,175. Apr. 13, 1926. Jacob Soderberg, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 5/13/24. Refers particularly to grinding machines for plate glass. A vertical spindle, a block in which the lower end of the spindle is mounted, a yoke pivoted to the block for rocking movement about a horizontal axis, a runner pivoted to the yoke for rocking movement about a horizontal axis at right angles to said axis about which the yoke pivots, interengaging stop means for limiting the rocking movement of the yoke, and for limiting the rocking movement of the runner.



GLASS-SEVERING APPARATUS. U. S. 1,580,809. Apr. 13, 1926. Carl A. Brown, East Cleveland, O., assignor to General Electric Co. Filed 11/3/22. The combination with a traction means for causing glass cane or tubing to travel in a substantially horizontal direction, of a severing means comprising a cutting wheel and rotating means therefor, the parts being mounted so that a simple rotating of the supporting means causes said cutting wheel to be brought into and out of the path of travel of said cane or tubing while maintaining wheel always in substantially the same plane and to sever predetermined lengths therefrom.



GLASS CUTTER. U. S. 1,579,980. April 6, 1926. Le Roy Anderson Walters, Miami, Fla. Filed 10/3/25. In a glass tube cutter a threaded rod, a graduated tube on the rod, means for holding the tube in adjusted position, a supporting element adjustable on the tube and adapted to engage and rest upon the upper end of the glass tube to be cut, and cutting means carried inside the tube.

Glass Factory Equipment and Supplies

Most of the information printed in this department comes direct from the manufacturers of the products described.

Bristol's New Model Pyrometer Controller

A new Bristol's Pyrometer Controller, Model 479, represents the result of four years' experimental work and trial under actual operating conditions in the field. It incorporates a number of additional and exclusive features. One is an extra wide scale, 7 inches in actual measurement, an important feature of the new controller. It is the same scale as furnished with Bristol's Indicating Pyrometer Model 420. The governor used to regulate the speed of the driving motor is said by the manufacturers to be absolutely reliable and positive in its operation. All parts of the governor mechanism and gears are accurately aligned and doweled to maintain permanent adjustment. The motor, with horizontal axis, is connected to the driving shaft by means of a non-metallic coupling which reduces friction and noise.

The mechanism which transmits power from the cam to the switch, and which causes the switch to move up and down about

BRISTOL PYROMETER CONTROLLER

four times a minute, is accurately set up and adjusted with set screws. To insure against slipping or any possible change in adjustment, every joint is pinned.

The plane of travel for the switch is fixed, and so designed to be horizontal when installed for operation: other parts are carefully adjusted with this as a reference place. The millivoltmeter movement is accurately adjusted so that the pointer swings in a plane absolutely parallel to the plane of motion of the switch. As a result of this relative adjustment, the switch, it is stated, operates with certainty at any part of the scale arc.

After the pointer has been aligned to follow the proper path, the anvil or plate against which the pointer tip, or steeple, is pressed, is adjusted so that the steeple on the pointer will always have sufficient clearance from the plate; but will still move a minimum distance when the switch is brought up against it.

The steeple which takes the pressure when the switch is brought up is, in effect, a small inverted wedge, the base of which is brought to rest on the anvil plate. The apex of this wedge is in contact with the small button which throws the switch over. It is apparent that the pressure on the steeple is all absorbed by the plate against which it is pressed. There can be no lateral thrust on the pointer, and no force along the pointer arm towards the pivots. The above method of construction and the very short distance which the steeple actually travels, reduces the pressure applied to the pivots to an almost negligible amount.

The complete moving mechanism which supports the switch is assembled in one unit, which unit is supported rigidly in a bearing having a total area of about 4.5 square inches, and is 6 inches long.

The switch-supporting mechanism is continuously held up against the depressor arm by a stiff spring, which supplies the power to raise the switch. The motor-driven cam forces the depressor arm down against the center shaft of the switch-supporting mechanism, which lowers the switch; the spring forcing it up when the depressor arm is raised.

Safety Adjustment Mechanism

The makers of this new model report that a decided improvement in it is the safety adjusting mechanism, for setting the position of the index at the point to which it is desired to bring the temperature.

A small hinged cover is used to enclose the adjusting knob. This knob cannot be operated until the cover is opened; and the act of opening the cover automatically forces the switch mechanism to its lowest position, where it is entirely free from the pointer. With this provision there is no possibility for the operator to damage the millivoltmeter movement by attempting to set the index at the instant when the switch is in contact with the pointer steeple.

The top of each of the small buttons against which the steeple rests when the switch is making contact, is a circle of about ¼-inch diameter. If the pointer is near the desired temperature, whether contact is made on the high or low side is decided by a sharp knife-edge. The knife-edge is in axial line with the index, and situated midway between the two buttons which operate the switch. The pointer is depressed on either side of the knife-edge and there can be no neutral position. After being guided to one side or other by the knife-edge, the steeple operates against the top of the button, which has sufficient area to make positive operation, and throws the switch to the maximum or minimum position.

Actual tests of temperature regulation made with this new controller prove that a movement of the pointer which is too small to be observed with the naked eye, will decide whether contact is made on the high or low side. The new instrument was developed and is manufactured by the Bristol Company, Waterbury, Conn.

New Motor Driven CO_2 Recorder

The latest development in the field of fuel economy by Republic Flow Meters Company, 2240 Diversey Parkway, Chicago, Ill., is their new motor driven CO_2 recorder. Heretofore the instrument supplied has been operated by city water pressure with excellent

MOTOR DRIVEN CO_2 RECORDER

satisfaction except in localities having bad water stoppages.

The motor driven type is already giving good service in many installations. The entire mechanism is completely submerged in oil thus reducing wear to the minimum and eliminating corrosion difficultics.

The cost of operating the New Republic Motor Driven CO_2 Recorder is low. Even its original cost, it is said, will be wiped out within two or three months of operation by savings effected. The small expense for oil and potash, required only two or three time a year is negligible compared with the advantages of having available a continuous record of the CO_2 content of the gases as a guide toward obtaining perfect combustion.

The Glass World and What It Is Doing

News of the Industry

The Glass Container Association will hold its annual meeting at Montreal on May 13, 14 and 15, instead of on April 29 and 30 as originally bulletined and as printed in the April issue of the GLASS INDUSTRY.

Date Changed for Glass Container Meeting

Shortly after the April issue went to press announcement was made by the association that owing to a conflict of dates in the case of many of the members, President Ferguson had suggested the postponement of the meeting in Montreal. After a consultation of the members of the board of directors, the date of the meeting was fixed as noted above. It was stated that while there may be some who would have preferred a different date, it was absolutely necessary to fix a positive date at that time, so the board of directors, committee men and many of the members will be in Montreal on May 12.

On Thursday, May 13, the convention will open with an address of welcome by the new mayor of Montreal and followed with an address by President Frank Ferguson on the subject, "The Developing Possibilities of Our Association Work." Thursday afternoon will be given up largely to statistical work, and one very attractive announcement in this connection is that Prof. Charles J. Bullock, chairman of the Committee of Economic Research at Harvard University, will talk on, "The Business Outlook." This promises to be a most important and interesting afternoon especially to glass manufacturers.

Friday is the day of the annual meeting, which, starting in the morning will be a typical business meeting consisting of reports of officers, chairmen of committees, heads of departments; also the nomination of directors and the transaction of business relating to the perpetuation of the association. The afternoon program promises to be a most interesting one, consisting probably of an address by one of the leading men in a great national organization and a talk by a member well known and highly respected in the industry.

On Friday evening there will be a wonderful dinner and program followed by an entertainment. Sir Charles Gordon, president of the Dominion Glass Company, the active vice-president of the Bank of Montreal, the leading financial institution of the Dominion of Canada, and an orator of international fame, will deliver an address. He will also sponsor an address by one of the leading statesmen of Canada, not yet announced.

On Saturday the golfers will have their inning at an exclusive country club at Montreal where there is an excellent course. The ladies are going to be taken care of by a ladies' committee consisting of two from each side of the border. The program will probably consist of an afternoon card game, an evening dinner, a theater party, also participation in sightseeing with the men on Saturday morning.

A statement was issued on April 22 to the effect that there will be at least three special cars leaving New York City and that arrangements are under way to have special cars leave Chicago and Pittsburgh. A number of people are seizing this opportunity for a real outing and are driving through to Montreal with their families, so this is likely to be more nearly a big family party than any meeting the Glass Container Association has ever held. All through the industry reports are coming in of a very special interest in the meeting, an interest that is partly due to the fact it will be like a trip abroad without crossing the ocean; also because it is Montreal and the possibilities of side-trips therefrom are plentiful.

Stained Glass Men Go Abroad This Month

Following the twenty-fifth annual meeting of the Stained Glass Association of America, to be held at the Hotel Raleigh, Washington, D. C., May 12, 13 and 14, a party of about twenty-five members and their friends will proceed to New York and sail on May 15 on the Royal Mail liner *Ohio* for Southampton, where they are due to arrive on May 24. On May 25, motor and other sightseeing trips through England will begin and many visits made to the cathedrals and other buildings containing notable stained glass work. Included in the itinerary is Wells, with its great cathedral; Bristol, Gloucester, Shrewsbury and Oxford. Several days will be spent in London visiting points of interest. An invitation through Professor W. E. S. Turner, has been accepted for the Association by S. L. Brown, chairman of the travel arrangements, to meet the Society of Glass Technology and the British Society of Master Glass Painters in London on June 1. From London, on June 4, the travelers will visit Canterbury and on June 5 cross the English Channel to Calais and go on to Amiens, making a stop at the cathedral there, and arriving at Paris for the night. The points then to be visited during the following week are Bourges, Tours, Poitiers, Angers, Le Mans, Chartres, then back to Paris. On June 19 those of the party who are returning home at once will go to Cherbourg and sail on the Cunard liner *Lancastria*, arriving in New York on June 28.

Experienced tour managers will conduct the party. The association extends a cordial invitation to glass men engaged in other branches of the business and to others interested in stained glass to join the party. Full information may be obtained from S. L. Brown, care the National Lead Company, 111 Broadway, New York.

American Refractories Institute Annual Meeting

The American Refractories Institute will hold its annual meeting at the Bellevue-Stratford Hotel, Philadelphia, Pa., on May 12, beginning at 10:00 a. m. (daylight saving time). The following technical papers will be presented:

"Service Conditions in Open Hearth Furnaces as affecting the Life of Refractories," by F. W. Schroeder, assistant chemist, U. S. Bureau of Mines, Pittsburgh, Pa.

"The Refractories Industry in New Jersey," by G. H. Brown, Head of the Ceramics Department, Rutgers University, New Brunswick, N. J.

"Mullite Refractories," by M. L. Freed, Research Fellow, U. S. Bureau of Standards, Washington, D. C.

"Industrial Research," by Dr. E. R. Weidlein, Director, Mellon Institute of Industrial Research, Pittsburgh, Pa.

"The Study and Development of Tests for Fire Brick with Special Reference to Spalling," by S. M. Phelps, Fellow, Refractories Fellowship, Mellon Institute, Pittsburgh, Pa.

"Permeability as a Measure of the Uniformity of Fire Brick," by Dr. A. E. R. Westman, Research Fellow, University of Illinois, Urbana, Ill.

(Dr. Westman will also discuss investigations being conducted on checker brick for water-gas sets.)

These papers and talks, together with the discussions that will be presented from the floor, should be of interest to both consumers and manufacturers of refractories. Arrangements are also being made to have one or two nationally prominent speakers present and

talk on subjects of general interest. Announcement of these speakers will be made later.

At noon a luncheon will be served in the hotel, reservation for which should be made through Dorothy A. Texter, Secretary, 2202 Oliver Building, Pittsburgh, Pa. The business session will be continued in the afternoon.

Invitations to attend this meeting are extended to all who are interested in the program, regardless of membership in the organization.

Plan to Standardize Methods of Glass Analysis

Plans are under way looking toward standardization of methods of analysis of glass and glass-making materials.

As a preliminary step, a standard sample of glass is being prepared by the Committee of Standards of the Glass Division of the American Ceramic Society.

This sample will be sent to any chemist, glass laboratory or glass technologist upon request. It is understood that the results of the analysis are to be reported to the committee who will treat them as confidential. The averages of all results will be sent to those reporting. In this way no names will be given or published and each analyst will be able to check his work with that of a great number of others.

In this way the actual need for standard methods will be determined. It is requested that all who are able to do so, will send in their methods of analysis for sand, soda, lime and glass. Several of the largest glass companies and consulting laboratories have signified their willingness to give out their methods of anlysis. "Quick methods" are also desired.

Requests for samples and the methods of analysis should be sent to A. R. Payne, Hazel-Atlas Glass Company, Clarksburg, W. Va.

Ford's St. Paul Glass Factory Begins Operations

Manufacturing operations are beginning in the first glass factory to be established in the state of Minnesota. Wood fires used for the preliminary heating up were discontinued on April 3 and producer gas ignited in the furnace of the Ford Motor Company's new plant at St. Paul, which is designed to have a maximum production of 12,000 square feet per day of polished plate glass. The same continuous process as employed at the Ford plants at Detroit is used. The gas producer plant, which will generate sufficient gas to supply the needs of the glass plant and all other manufacturing operations at this place, and all the other equipment is most modern. The layout and construction of the buildings has been developed to a point of architectural design and beauty which bears very little resemblance to the ordinary glass plant. According to Superintendent A. W. Bendick, nothing has been spared to make the appearance of the glass works harmonize attractively with the rest of the Twin City plant of the Ford Motor Company. About half of the Twin City's glass production will be used at the Ford plant there and the remainder shipped to assembly plants in the mid-west.

Plate Glass Production, First Quarter, 1926

The production of polished plate glass in the United States for the month of March, 1926, as announced by P. A. Hughes, secretary of the Plate Glass Manufacturers of America on April 20, amounted to 11,616,933 square feet, as compared with 10,543,757 square feet in February.

The total production for the quarter ending March 31st was 32,889,367 square feet, as compared with 27,015,881 square feet produced in the first quarter of 1925, an increase of nearly six million square feet for the three months just past. This indicates that a substantial part of the new plant equipment added last year has been put into production. Should this rate of increase over 1925 be maintained all through 1926 the total production for the year will approach 150,000,000 square feet.

Owens Bottle Company's Successful Year

The Owens Bottle Company reports for 1925 a net income of $5,051,050, after charges and Federal taxes, which is equal, after preferred dividends, to $6.77 a share earned on $16,528,225 of $25 par common stock. This compares with $3,710,543 or $4.72 a share earned on $16,513,750 outstanding common stock in 1924.

The manufacturing profit after depreciation was $5,333,133. Royalties were $2,156,148 and other income $734,575, thus making a total income of $8,223,856. Expenses were $2,314,173, while Federal taxes reached $858,633. In 1924 the royalties and other income totaled $2,948,955, while the expenses and taxes were $2,958,427. The manufacturing profit in 1924 was $3,720,015.

Foreign Glass Agency in New Office

On April 24 the offices of J. Vaurie, sole agent in the United States for Société de St. Gobain, Chauny et Cirey, Comptoir Français d'Exportation de Glaces, Deutsche Spiegelglas Ausfuhr Gesellschaft, Parra-Mantois & Co. (scientific optical glass), Verreries de Bagneaux (spectacle glass), were moved to Metropolitan Tower, 1 Madison avenue, Room 190, New York. The new telephone numbers are Ashland 1127 and 1128.

Advertising Gas As An Industrial Fuel

In an effort to further the use of manufactured gas in industry, the American Gas Association is conducting a national advertising campaign in twenty-one trade magazines for the second consecutive year.

The use of gas for industrial heating purposes has grown 63.4 per cent in the last five years, according to statistics issued by the association. The actual increase was 43,975,447,000 cubic feet.

The Pittsburgh section of the American Ceramic Society at a recent meeting elected the following officers for 1926-1927: Chairman, E. J. Casselman, Mellon Institute, Pittsburgh, Pa.; vice-chairman, C. E. Fulton, Pittsburgh Plate Glass Company, Tarentum, Pa.; treasurer, G. R. Pole, and secretary, C. H. Geister, both of the Mellon Institute. During the meeting J. W. Cruikshank, retiring chairman, gave an interesting illustrated talk on "The Development of Drawing Sheet Glass as Shown by Patent Office Records."

March, 1926, saw the placing of the largest volume of construction contracts for any March on record, according to the F. W. Dodge Corporation building report issued April 11. March total of building and engineering contracts in the 37 states east of the Rocky Mountains was $597,879,300. The increase over February was 53 per cent; over March of last year, 22 per cent.

The American Bottlers of Carbonated Beverages have been working on a campaign to raise a fund of $2,000,000 by voluntary contributions from manufacturers of bottled carbonated beverages and allied industries, to be used to cover the cost of a four years' advertising campaign designed to increase the use of bottled beverages.

A new use for glass has been developed by the attachment of agate or other colored glass balls on the end of gear shift levers in automobiles. The Rodefer Glass Company, Bellaire, O., is furnishing quantities of these balls to the motor car manufacturers.

Trade Activities

The Kenwood Glass Company, 124 West 47th street, Chicago, Ill., has been incorporated with a capital of 31 shares non-par value to deal in glass.

The Licking Window Glass Company, Utica, O., met with a loss of about $5,000, not covered by insurance, when its warehouse was destroyed by fire early in April.

The Atlantic Bottle Company's tank at Tarentum, Pa., which broke some weeks ago causing considerable damage, is being repaired by the H. L. Dixon Company, Pittsburgh, Pa.

The Hart Glass Company, Dunkirk, Ind., has awarded a general contract to G. W. Heinzelman & Son, Marion, Ind., for a one-story addition 75 by 461 feet, reported to cost about $75,000.

The Standard Glass Company has been incorporated at

Knoxville, Tenn., with a capital of $12,000 to deal in glass and manufacture and deal in show cases, mirrors and various glass articles.

The Wheeler-Meserve Glass Company, Boston, Mass., has been organized with a capital of $50,000 by Harry A. Wheeler, Gordon Wheeler, Brookline, Mass., and Arthur H. Meserve, Malden.

The Turner Brothers Company are reported by Ross Wilson, superintendent, to be running three tanks at the Winchester, Ind., plant as well as the large tank at the Terra Haute plant.

Ball Brothers Company have completed repairs to their Huntington, W. Va., plant, formerly the Schram Glass Manufacturing Company, and manufacturing operations will be resumed shortly.

The C. L. Flaccus Glass Company, which recently moved its office to Tarentum, Pa., is now housed in a building adjoining its plant. The company reports the best business and best production in its history.

According to an advertisement recently published in Medford, N. J., newspapers, the **Star Glass Company, Ltd.,** a partnership association formed in 1880 under the statutes of New Jersey, has been dissolved.

Recurrent rumors that the **Pennsylvania Plate Glass Company,** Kane, Pa., were about to start construction work on the proposed plant at Durant City, Pa., are denied by the company's president, W. A. James.

The Corydon Glass Company, Corydon, Ind., has been incorporated with preferred capital stock of $100,000 and 6,000 shares of no par value, to manufacture glassware. The incorporators are: J. B. Greer, G. B. Crowe, A. B. Richert and R. Atwood.

The General Flat Glass Company, Mannington, W. Va., has been incorporated with an authorized capital stock of $300,000 to manufacture window glass, flat glass, etc. The incorporators are S. E. Phillips, W. S. Farbee, F. L. Koen, C. H. Long and C. B. Deveny.

The sale of the property of the defunct **General Glass Company,** Geneva, N. Y., which was scheduled to be disposed of by the sheriff on April 7, was halted by official order to determine whether the city or county officials have the prior claims in the matter of liens on the property in question.

The Aetna Glass Company, Vineland, N. J., manufacturers of and dealers in medical, surgical and hospital glassware, flint and opal towel bars, announce that in the near future they will produce glassware for laboratory and general chemical purposes, including cylinders, burettes, pipettes, etc.

The name of the **Ford Motor Company's** River Rouge plant was changed to the "Fordson Plant," according to an announcement made March 22 by Edsel B. Ford. The name of the town in which the plant is located, which was formerly known as Springwells, has also been changed to Fordson.

The Universal Glass Products Company, Parkersburg, W. Va., whose factory was seriously damaged by fire in March, are reported to have let a contract to the Plate Construction Company, of Parkersburg, for the construction of a $40,000 plant, which will be equipped with automatic machinery.

The Eden Glass Company, Knox, Pa., recently began manufacturing operations on green and amber bottles. The company occupies a main building, 50 by 190 feet, with an additional frame warehouse 25 by 96 feet, and it is reported that when in full operation the concern will give employment to about 350 employes.

The Queen City Glass Company, Cumberland, Md., recently organized with R. K. Schauwecker, president and general manager, and C. H. Yergan, secretary and treasurer, has taken over the plant of the Cumberland Ice Company, which will be remodelled for the manufacture of lighting glassware, etc. It is reported that contracts have been awarded for melting furnace, molds, finishing machinery, etc.

Stockholders of the **Ohio Glass Products Company,** Massillon, O., were informed by C. E. Stuart at a meeting held early in April that the operating budget prepared by the officials showed that a minimum of $65,000 working capital must be put into the business if the factory is to continue operations. It was asserted that the plant has been overhauled and that the equipment is in good condition for commencing operations.

An application has been filed by Nicholas Kopp, H. A. Ross and W. F. McNaugher for the charter of an intended corporation to be known as the **Kopp Glass, Inc.** It is reported that the new company has been organized to take over the Swissvale, Pa., plant of the Pittsburgh Lamp, Brass & Glass Company and will manufacture products similar to those originally made by that concern, including gas and electric lighting glassware, signal glass, etc.

The Corning Glass Works, during April, had a force of men at work in their Wellsboro, Pa., plant, preparing equipment for use in melting and manipulating glass experimentally. It is stated definitely that the plant will not be operated commercially and that the organization engaged in the experimental work will consist of engineers and plant assistants to the number of 20 or 30, most of whom are now employed at the experimental department of the Corning, N. Y., factory.

The Mathieson Alkali Works, Inc., 250 Park avenue, New York, announces the appointment of William A. Field, formerly of St. Louis, to be manager of the Chicago district with offices at 310 S. Michigan avenue. Frederick H. Lovenberg, formerly of the New York sales office, is now in charge of the St. Louis district sales office. Arrangements have been completed with the Fields Point Manufacturing Corporation, Providence, R. I., which will afford the latter corporation the general support and extensive resources of the Mathieson Alkali Works. Daniel Townsend, president of the former concern, will have charge of both companies' sales in the New England territory.

Industrial Publications

Speed Reducers—The new general catalog of the Foote Bros. Gear & Machine Company, Chicago, Ill., will be available for distribution about the middle of May. In addition to being a complete price list of the company's spur and worm gear speed reducers, flexible couplings, sprockets and industrial gears of all kinds, contains a wealth of engineering information on gearing transmission and mechanical engineering subjects that makes it valuable as a reference book. Executives and engineers interested in gearing and speed reduction subjects are invited write for a copy.

The Brown Instrument Company, Philadelphia, has recently issued two publications of interest to the glass industry, entitled "Instructions for the Installation and Care of Thermo-Electric Pyrometers" and "Brown Resistance Thermometers—Catalog No. 92." The latter publication (20 pages and cover) reproduces in actual colors the complete newly designed line of Brown resistance thermometers, and pictures and describes in detail the new Brown continuous recording resistance thermometers.

The publication entitled "Instructions for the Installation and Care of Thermo-Electric Pyrometers" contains 80 pages and cover, with 90 illustrations in halftone and line. It covers the following subjects: Theory of thermo-electric pyrometry; Installing pyrometers; Instruments installed ready for use; Indicators; Continuous recorders; Checking pyrometer installations and a complete index.

These publications are available to those interested in temperature measurements, and can be obtained by writing to The Brown Instrument Company, Wayne Avenue, Philadelphia, Pa.

Quigley Refractory Gun. The Quigley Furnace Specialties Company, 25 Dey street, New York, has issued a booklet describing a device for doing mechanically a large part of the work ordinarily done by hand in repairing refractory walls. The booklet describes how, with this "gun" it is possible to prevent a lot of expensive reconstruction work by patching weak places as soon as they are discovered. Pre-mixed plastic refractory materials, consisting of Hytempite and aggregates of appropriate size for the job in hand are placed in the gun, which shoots the plastic mixture at high velocity against any desired part of the wall or arch. The mixture will stick to a hot or cold wall. In many cases hot repairs are possible. This material can be used advantageously on lehrs, outer walls of furnaces and tanks and in other places where the Hytempite will not come in contact with the molten glass.

W-S-M Mechanical Gas Producer Type "L"—A new 48 page bulletin No. 85 has been issued by the Wellman-Seaver-Morgan Company, 7002 Central avenue, Cleveland, O. In addition to a complete and detailed description of the producer with data on sizes, capacity, etc., a great deal of valuable information is given on coal, gasification of coals from West Virginia, Pennsylvania, Indiana and Illinois. A table showing classification of English coals in W-S-M gas producer Type "L" is also given. Gasification of coke, producer gas economics and gas producer efficiency are also treated. The operation of the producer is covered quite thoroughly. A large number of typical analyses of American coals is given and other data presented in unusually serviceable form. The bulletin contains many blue prints showing the dimensions and details of the producer. Copies of this interesting bulletin may be obtained from the company on request.

Personals

W. C. Davis was re-elected president of the Foote Bros. Gear & Machine Company, 237-247 N. Curtis street, Chicago, Ill., at a recent meeting of the directors. **E. H. Vogt** was elected secretary and assistant treasurer.

J. A. Voorhies, until recently connected with the Hazel-Atlas Glass Company, is now engaged in consulting work along the line of fuel problems, glass making, etc. His address is 662 St. Marks avenue, Brooklyn, N. Y.

R. L. Clause, who has been in charge of the manufacturing department of the Pittsburgh Plate Glass Company, was elected vice-president at the recent annual meeting. All the other officers of the company were re-elected.

Edward Miller, proprietor of the Miller Machine & Mold Works, manufacturers of glass house machinery, 705-719 Ann street, Columbus, O., will sail for Europe on May 18. It is his intention to visit the following countries: England, Ireland, Scotland, France, Belgium, Switzerland, Luxemburg, Germany, Italy and Spain. Mr. Miller is combining business with pleasure on this trip. He will be accompanied by Mrs. Miller and son Florian. Mr. Miller will make his headquarters with his European representative, the British-Hartford-Fairmont Syndicate, 142-3 Audrey House, Ely Place, London, E. C. 1, where he can be reached by anyone desiring to communicate with him. It is his intention to visit every factory in the countries visited using the "Edward Miller" machines.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce.

India: 19985, glass, sheet, plate and window; 19948, glassware.
Germany: 19800, machine for cutting graduations on glass cylinders; 20127, glass bottle manufacturing machinery; 20199, grinding machinery for plate glass.
Spain: 20154, cut glass articles.
Africa: 20138, silvered and beveled glass.

Coming Meetings

THE GLASS CONTAINER ASSOCIATION will hold its annual meeting at Montreal, Canada, May 13, 14 and 15.

THE AMERICAN REFRACTORIES INSTITUTE will hold its annual meeting on May 12 at the Bellevue-Stratford Hotel, Philadelphia, Pa.

THE SECOND CHEMICAL EQUIPMENT AND PROCESS ENGINEERING EXPOSITION of the Association of Chemical Equipment Manufacturers will be held in Cleveland, May 10 to 15.

THE STAINED GLASS ASSOCIATION OF AMERICA, formerly the National Ornamental Glass Manufacturers Association, will hold its next annual convention at the Hotel Raleigh, Washington, D. C., May 12, 13 and 14.

THE SOCIETY OF INDUSTRIAL ENGINEERS will hold its thirteenth national convention at the Bellevue-Stratford Hotel, Philadelphia, June 16 to 18 inclusive. Papers and discussions will deal with practical methods for eliminating waste.

THE NATIONAL LIME ASSOCIATION will hold its eighth annual convention at French Lick Springs, Ind., on June 8 to 11.

Inquiries Received

For Further Information Address: THE GLASS INDUSTRY

328. We are considering the use in a large exclusive store of a molded and pierced glass transom above woodwork. Depth would be about 4 feet, and about 500 running feet would be required. The character of this work would be on the order of a commercialization of the type used by Lalique in his fine vases, as found illustrated in your April number. Can you refer us to any one who is competent to execute this work? (April 26.)

329. Will you please give us the names of manufacturers of colored glass of a limited heat-resisting quality. We wish to use this glass in borderlights and footlights of theatres in place of colored gelatin now used. The size required would be about 10 inches in diameter for the borderlights, and 5 inches in diameter for the footlights. The colors desired are ruby, amber, blue and green. We estimate the temperature this glass will have to work under will be 400 deg. F. (April 4.)

330. Will you kindly furnish me with a list of dealers or distributors of plate glass, Vitrea drawn sheet glass, Libbey-Owens sheet glass, etc., for automobile replacement work? I also would like to know where to buy rouge for polishing glass edges, and also where to buy glass cutters tools, such as squares, measuring sticks, etc. (April 26.)

331. (From a German glass works.) We intend to install a machine to manufacture flat wired glass, the wire to have hexagonal meshes and a silvery color. The finished product must be of first quality. Would like to receive full particulars of such machinery from manufacturers. (April 28.)

Glass Stock Quotations

PITTSBURGH STOCK EXCHANGE, APRIL 23, 1926.

Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.

	Bid	Ask	Last
American Window Glass Machine, com.	70	..	..
American Window Glass Machine, pfd.	90	..	..
American Window Glass, pfd.	108	..	71
United States Glass	17⅜	17	17¾
Pittsburgh Plate Glass, com.	280	..	..
Standard Plate Glass, com.	7	..	..
Standard Plate Glass:			
Preferred cumulative	40	..	..
Prior	79	79	..

WHEELING STOCK EXCHANGE, APRIL 23, 1926.

	Bid	Ask	Last
Hazel-Atlas	..	..	39½
Imperial	..	..	72
Fostoria	..	..	150
Central	..	..	75

TOLEDO STOCK EXCHANGE, APRIL 23, 1926.

	Bid	Ask	Last
Owens Bottle Machine, com.	..	..	60
Libbey-Owens Sheet Glass, com.	..	..	145
Libbey-Owens Sheet Glass, pfd.	..	..	114

READERS WANTS AND OFFERS

Capital Wanted

GLASS MANUFACTURER, having an established business in Bohemia and Germany, producing glass bars, tubing and rods in all colors and of the highest quality desires connection with capitalist or banking house, for the purpose of starting a glass factory in the United States, in order to produce glassware of all kinds, near the point of their consumption. Please send answers under "Colored Glass" to GLASS INDUSTRY, 50 Church street, New York.

Window Glass Salesman

WANTED: Thoroughly experienced window glass salesman to call on jobbers and sash and door manufacturers in territory east of Mississippi. Applicant must be a salesman of recognized ability and good reputation. Give full particulars in first letter. Address, J. Parkin, 2300 Division Street, St. Louis, Mo.

Back Numbers of Glass Industry

THE TOLEDO (OHIO) PUBLIC LIBRARY in order to have a complete set of copies of the GLASS INDUSTRY in the new glass section desires to obtain the issues of November and December, 1920, all issues of 1921, and February and March, 1922, either as gifts or for purchase. Kindly address CARL VITZ, Librarian.

Current Prices of Glass-Making Materials

April 23, 1926

Quotations furnished by various producers, manufacturers and dealers

		Carlots	Less Carlots
Acid:			
Citric	lb.	.45	.46
Hydrochloric (HCl) 20° tanks, per 100 lb.		.90-1.00	..
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	..	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.25	5.50
Sulphuric (H_2SO_4) 66° tank cars	ton	14.00-15.00	..
Tartaric	lb.	..	.28½
Alcohol, denatured	gal.	..	..
Aluminum hydrate (Al $(OH)_3$)	lb.	.05	.05½
Aluminum oxide (Al_2O_3)	lb.	..	.05
Ammonium bifluoride (NH_4 FHF)	lb.	..	.23-.23¼
Ammonia, water (NH_4OH) 26° drums	lb.	..	.04
Antimony, metallic (Sb)	lb.	..	..
Antimony oxide (Sb_2O_3)	lb.	..	.17½-.17¾
Antimony sulphide (Sb_2S_3)	lb.	..	.18
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.93½	.04
Barium carbonate ($BaCO_3$)			
Precipitated	ton	46.00-51.00	51.00-54.00
Natural powdered	ton	42.00-44.00	45.00-46.00
Natural, powdered, imported	ton	..	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.07¼	.08
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05½	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.04¾	.05-.05½
Boric acid (H_3BO_3)	lb.	.09	.09¾
Refined	lb.	.08½-.09	.09-.09½
Cadmium sulphide (CdS)—			
Red	lb.	..	1.25
Orange	lb.	..	1.05-1.25
Yellow	lb.	..	1.40
Chromium oxide (Cr_2O_3)	lb.	.29	.30-.32
Cobalt oxide (Co_3O_4)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	.30
Cryolite ($Na_3Al\ F_6$)	lb.	..	.09½-.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.35
Feldspar—			
100 mesh	ton	12.50-20.00	16.00-22.00
80 mesh	ton	..	..
40 mesh	ton	..	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	40.00	..
" " 90%	ton	38.00	..
Formaldehyde	lb.	.09	.09½
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.02-.02¾
Black (FeO)	lb.	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	13.00-23.00	..
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb	.10½-.11¼	.11½
Litharge (PbO)	lb.	.10¾	.11
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15	2.30
Limestone ($CaCO_3$)	lb.	..	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.04	.04½
light (in bbls.)	lb.	.22	.24-.25
extra light (in bbls.)	lb.	..	37
Magnesium carbonate ($MgCO_3$)	lb.	.06¼	.06¾
Manganese 85% (MnO_2)	lb.	.05	.05½
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	19.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¼	.08½
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06½	.06¾
Hydrated 80-85%	lb.	.05¾	.06
Potassium chromate (K_2CrO_4)	lb.	..	.27
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.07⅝
Potassium nitrate (KNO_3) (gran.)	lb.	.06⅛	.06¾
Potassium permanganate ($KMnO_4$)	lb.	.14½	.15½
Powdered blue	lb	..	.24-.26
Rochelle salts, bbls.	lb.	..	.20
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.20	.25
Salt cake, glassmakers (Na_2SO_4)	ton	20.00-22.00	23.00-30.00
Selenium (Se)	lb.	..	2.10-2.15
Silver nitrate ($AgNO_3$)	oz.	..	.45⅝
Soda ash (Na_2CO_3) dense, 58%—			
Bulk Flat per 100 lb.		1.35-1.40	..
Bulk, on contract Flat per 100 lb.		1.35	..
In barrels Per 100 lb.		1.69	2.40
In bags Per 100 lb.		1.45	..
Spot orders .05 per 100 lbs higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.06¾
Sodium hydrate (NaOH) (caustic soda) Per 100 lb.		3.60	4.16
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04⅛
95 per cent. Per 100 lb.		2.63	2.80
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¼	.05
Sodium uranate (Na_2UO_4)	lb.	..	1.15
Sulphur (S)—			
Flowers, in bbls. Per 100 lb.		3.35	3.65-3.90
Flowers, in bags Per 100 lb.		3.00	3.30-3.55
Flour, heavy, in bbls. Per 100 lb.		2.65	2.95-3.20
Tin chloride ($SnCl_2$)) (crystals)	lb.	..	.43
Tin oxide (SnO_2) in bbls.	lb.	..	.68
Uranium oxide (UO_3), 100 lb. lots	lb	..	1.20-1.25
Zinc oxide (ZnO)	lb.	.07⅛	.07¾

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to March, 1926

		February 1925 Quantity	February 1925 Value	February 1926 Quantity	February 1926 Value	Eight Months Ending February 1925 Quantity	Eight Months Ending February 1925 Value	Eight Months Ending February 1926 Quantity	Eight Months Ending February 1926 Value
Glass and glass products (total)		.....	$524,705	.....	$659,951	.....	$5,283,626	.....	$5,663,939
Plate and window glass—									
Window glass, common, box 50 sq. ft.		4,332	23,235	6,135	19,512	25,245	124,131	21,656	100,829
Plate glass, unsilvered, sq. ft.		134,593	26,174	202,304	29,977	1,025,070	273,859	1,151,120	260,770
Other window and plate glass	lbs.	87,720	11,692	185,213	13,990	1,263,806	130,476	1,682,788	186,905
Glass containers (bottles, vials and jars)		.....	180,649	.....	199,425	.....	1,835,735	.....	1,786,346
Table glassware, plain		.....	99,802	.....	112,136	.....	1,133,176	.....	1,136,190
Table and other glassware, cut or engraved		.....	5,327	.....	11,322	.....	112,710	.....	112,617
Lamp chimneys and lantern globes	lbs.	164,079	25,706	214,855	41,364	1,282,663	218,976	1,287,776	260,441
Globes and shades for lighting fixtures	lbs.	117,295	32,675	137,555	43,569	947,821	270,299	1,177,974	352,634
Chemical glassware	lbs.	18,440	12,840	20,595	16,995	177,096	136,909	155,806	144,485
Electrical glassware, except for lighting	lbs.	130,090	17,182	537,704	44,441	1,138,862	138,478	2,042,936	212,177
Other glassware		.....	89,423	.....	127,220	.....	908,877	.....	1,110,545

IMPORTS

Corrected to March, 1926

Glass and glass products (total)		.....	1,379,975	.....	1,367,058	.....	11,404,635	.....	11,555,622
Cylinder, crown and sheet—									
Unpolished	dut. lbs.	5,608,553	276,274	4,779,181	197,941	24,041,159	1,292,108	29,223,294	1,411,052
Bent, ground, beveled, colored, painted, etc., and polished	dut.	.....	45,779	.....	24,518	.....	323,009	.....	328,020
Plate glass	dut. sq. ft.	1,420,747	646,352	1,649,621	601,290	10,495,681	4,945,913	12,026,764	4,381,606
Containers—bottles, vials, etc.	dut.	.....	11,095	.....	27,855	.....	110,307	.....	144,299
Table and kitchen utensils	dut.	.....	4,305	.....	3,206	.....	110,495	.....	106,915
Glassware, cut or decorated	dut.	.....	156,159	.....	163,933	.....	1,496,743	.....	1,775,303
Blown glassware n.e.s.—									
Bottles, ornaments, etc.	dut.	.....	47,513	.....	76,454	.....	1,359,000	.....	1,381,056
Bulbs for electric lamps	dut. No.	2,004,078	20,529	1,568,385	17,173	11,649,593	135,885	9,599,637	103,820
Chimneys, globes, shades, etc.	dut.	.....	98,841	.....	95,234	.....	758,817	.....	671,260
Articles and utensils for chemical, scientific and experimental purposes	dut.	.....	18,933	.....	35,772	.....	217,202	.....	322,373
Other glassware	dut.	.....	54,195	.....	123,682	.....	655,156	.....	929,918